CLINICO-HAEMATOLOGICAL AND BIOCHEMICAL ALTERATIONS IN ETHYLENE GLYCOL INDUCED ACUTE NEPHROTOXICITY IN COW CALVES

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Summary

Ethylene glycol was given orally in 6 crossbred male cow calves @ 12 ml/kg b wt for 2 days continuously to develop acute nephrotoxicity and monitor blood chemicals profile in affected calves. Progressive depression, hypersalivation, ataxia, incoordination, staggering gait, grinding of teeth, recumbency, coma, convulsions and death were prominent symptoms in affected calves. Respiration and pulse rates were increased whereas body temperature and rumen movements were low. Haematological investigations revealed increase in total erythrocyte count, platelets count and packed cell volume till death and total leukocyte count up to day 3 which decreased on day 4 and 5. These calves revealed azotaemia, reduction in calcium, chloride and potassium and rise in sodium and AST, ALT and alkaline phosphatase enzymes activity.

(**Key Words** : Ethylene Glycol Toxicity, Haematology, Biochemistry, Nephrotoxicity, Cow Calves)

Introduction

Ethylene glycol, a dihydric alcohol widely distributed in the environment, is reported to be one of the common causes of poisoning in developed countries (Oehme, 1974). It is in common use in antifreeze, detergents, pharmaceuticals, cosmetics and deicers (Paton, 1989). Ethylene glycol intoxication is common among domestic animals and has been observed in dogs, cats, pigs and poultry (Black, 1983). Though deaths have been reported in many animals including man in ethylene glycol poisoning (Nunamaker et al., 1971), but detailed reports regarding changes in blood in calves are lacking and there seems to be no report available from India. This paper reports clinico-haematological and biochemical changes in ethylene glycol induced acute nephrotoxicity in crossbred cow calves.

Materials and Methods

Twelve apparently healthy crossbred male cow calves (Jersy crosses) of about 4-5 months of age and weighing around 40-50 kg were used. The animals were examined clinically and their blood, faeces and urine samples were analysed routinely to rule out concurrent infection. They were randomly divided into 2 groups of 6 each. Acute nephrotoxicity was developed in the calves of group A by giving ethylene glycol @ 12 ml/kg b wt for 2 days continuously by oral route whereas calves of group B served as healthy control.

All the animals were examined daily and their blood samples were collected just before giving ethylene glycol (0 day) and then at every 24 hr interval till their death. Rectal temperature (°F), respiration and pulse rates (per min) and rumen movements (per 5 min) were recorded in the morning and clinical symptoms were observed whenever manifested. About 2 ml blood was collected in clean glass vials using EDTA salt as anticoagulant for estimation of total erythrocyte count ($\times 10^6/\mu l$) , total leukocyte count ($\times 10^3/\mu l$), platelets count ($\times 10^5/\mu l$) and packed cell volume (%) as per standard methods. Serum separated from clotted blood samples was used for estimation of urea nitrogen, creatinine, uric acid, calcium, chloride, sodium and potassium and activity of AST, ALT and alkaline phosphatase enzymes by the standard methods described by Henry (1974). The results were analysed statistically by two-way analysis of variance (Snedecor and Cochran, 1967).

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Results

Within 2 1/2 to 4 hr of ethylene glycol ingestion, calves of group A showed progressive depression, hypersalivation, anorexia, staggering gait, incoordination, ataxia and slight dilatation of pupil. After 12 hr, they revealed lateral recumbency and abdominal pain as evidenced by kicking at the belly. After 24 hr, 3 calves suffered from haemoglobinuria, grinding of teeth and convulsions. The respiration rate increased and during convulsive stage, it was very rapid and forceful indicating dyspnoea and was more abdominal type with open mouth breathing. All the calves after 48 hr, went into coma and there was decreased reflex responsiveness. At this time, 2 calves developed loose faeces which was streaked with blood and their rumen became tense and atonic. Anuria was noticed in 2 and 4 calves after 48 and 72 hr, respectively. Rumen became tense and atonic after 72 hr. Two calves died on 3rd day, 3 on 4th day and remaining 1 on 5th day post administration of ethylene glycol.

There was significant reduction in body temperature from 102.50 ± 0.20°F initially to 94.00 ± 0.0°F on day 5. Respiration and pulse rates were increased initially upto day 3 and their values on this day were 62.50 ± 2.46 and 110.50 ± 1.19/min and then decreased subsequently to 12.00 ± 0.0 and 58.00 ± 0.0/min on day 5. The rumen movements decreased initially and were absent from day 3 onwards. TEC, platelets count and PCV were significantly elevated. Initially TEC was 6.34 ± 0.22 and became 16.82 ± 0.0 × $10^6/\mu l$ and platelets count increased to 6.26 ± 0.0 from initial value of 1.98 ± 0.04 × $10^5/\mu l$. However, PCV values on day 0 and 5 were 22.25 ± 1.65 and 43.00 ± 0.0. TLC increased from day 1 to 3 and decreased on day 4 and 5 and its values on day 0, 3 and 5 were 8.13 ± 0.34, 12.95 ± 0.20 and 4.60 ± 0.0 × $10^3/\mu l$.

In the calves of group A, urea nitrogen level was 28.66 ± 1.17 mg/dl which increased to 322.00 ± 0.0 mg/dl on day 5. Creatinine and uric acid levels were progressively increased upto 5th day (figure 1). The affected calves revealed reduction in calcium and chloride from day 1 to 5 and potassium from day 2 to 5 whereas sodium level was significantly higher from day 1 to 5 (figure 1). The activities of AST, ALT and alkaline phosphatase enzymes were increased progressively and significantly from day 1 to 5 in all calves of group A (figure 1).

Discussion

The symptoms of ethylene glycol toxicity as noticed here, were recorded by Kersting and Nielsen (1965) in small animals and Crowell et al. (1979) in cattle. Body temperature decreased due to depressant effect of ethylene glycol and anorexia, coma and convulsions developed probably due to uraemia (Paton, 1989). Recumbency and death occurred as a result of metabolic acidosis, hyperosmolality, hypocalcaemia and azotaemia as noticed by Crowell et al. (1979) in cattle. Tachycardia and tachypnoea developed secondary to acidosis. Similar observations were made by Paton (1989) and Herd (1992) also in small animals. Initial rise in PCV, TEC and platelets count may due to severe dehydration as a result of diuresis. Paton (1989) and Herd (1992) reported similar changes in small animals. Leukocytosis was due to ethylene glycol intoxication or metabolic disturbances caused by uraemia. In renal damage caused by lead or mercury ingestion, Coles (1974) reported leukocytosis.

The rise in urea nitrogen and creatinine values was as a result of renal damage caused by ethylene glycol ingestion whereas uric acid was increased probably due to liver involvement. Similar changes in urea nitrogen and creatinine were mentioned by Paton (1989) and Herd (1992). Estimations of urea nitrogen and creatinine are common tests to ascertain kidney damage. Hypovolaemia caused by dehydration results in impaired excretion of urea and creatinine and their values are increased in circulation. Calcium level was decreased probably due to formation of calcium oxalates by ionic calcium of circulation and these oxalates accumulate in the vasculature and renal tubules (Dickie et al., 1978 and Boermans et al., 1988).

In renal disorders, chloride ions are lost in urine as a result of tubular defect (Kaneko, 1989) and thereby its level in circulation becomes low. Singh et al. (1983) noticed hyperchloraemia in acute renal dysfunction. Rise in sodium concentration may be as a result of dehydration (Kaneko, 1989). Joshi et al. (1989) reported rise in sodium level in sheep suffering from ureamia. Hypernatraemia occurs in initial stage of diarrhoea, vomition or renal diseases if loss of water exceeds the electrolyte lost. Hypokalaemia developed as a result of excess mineralocorticoid and altered renal tubular function due to tubular acidosis or post obstructive stages (Carlson, 1989). The activities of AST and ALT are increased due to cell necrosis of different tissues including liver and kidney (Kaneko, 1989). Joshi et al. (1989) also reported similar changes in sheep suffering from uraemia. The activity of alkaline phosphatase was elevated which is due to involvement of liver (Kaneko, 1989) in ethylene glycol toxicity.

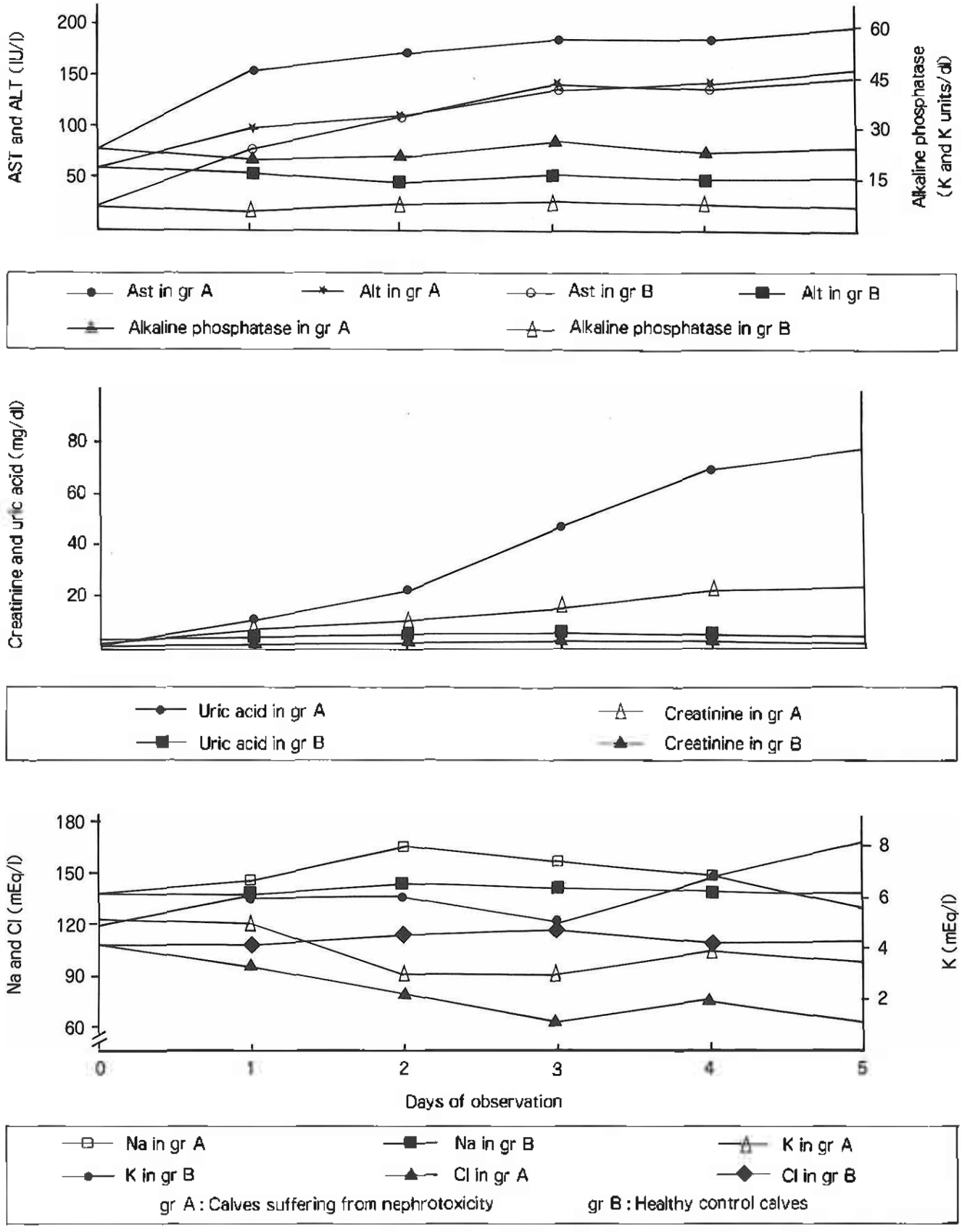

Figure 1. Biochemical changes in experimentally induced acute nephrotoxicity in cow calves.

TABLE 1. BIOCHEMICAL CHANGES IN EXPERIMENTALLY INDUCED ACUTE NEPHROTOXICITY IN COW CALVES (MEAN ± S.E.)

Parameters	Group	Days of observation					
		0	1	2	3	4	5
Urea nitrogen	A	28.66±1.17	52.66±3.77**	109.90±6.41**	172.50±9.69**	241.00±8.89**	322.00±0.00**
(mg/dl)	B	28.46±0.62	30.00±2.16	29.00±2.48	26.66±1.69	27.66±2.43	30.00±1.40
Creatinine	A	1.80±0.24	7.00±0.68**	10.80±0.62**	17.71±0.84**	23.70±1.05**	25.70±0.00**
(mg/dl)	B	1.70±0.17	1.55±0.10	2.50±0.21	2.65±0.33	2.35±0.22	2.37±0.20
Uric acid	A	2.79±0.35	11.00±0.79**	23.00±1.70**	48.00±2.24**	70.00±3.81**	78.00±0.00**
(mg/dl)	B	3.17±0.23	3.21±0.20	4.12±0.63	4.00±0.43	3.86±0.19	3.82±0.28
Calcium	A	10.83±0.61	7.16±0.43**	4.82±0.31**	4.00±0.24**	3.00±0.17**	2.63±0.00**
(mg/dl)	B	10.50±0.70	10.50±0.60	9.34±0.55	11.12±0.76	12.03±0.68	11.41±0.42
Chloride	A	109.85±1.50	96.45±1.49**	79.55±2.01**	63.55±1.88**	75.78±1.32**	61.70±0.00**
(mEq/l)	B	108.29±1.74	108.65±1.88	114.00±2.14	116.41±1.97	110.48±1.86	110.66±1.75
Sodium	A	142.00±2.59	146.00±2.12	165.00±2.25**	157.00±2.22**	148.00±1.61*	166.00±0.00**
(mEq/l)	B	139.50±1.32	137.25±4.38	144.00±2.94	141.50±4.05	139.25±3.81	138.25±2.25
Potassium	A	5.92±0.31	5.32±0.42	3.32±0.42**	3.23±0.10**	4.00±0.61**	3.50±0.00**
(mEq/l)	B	5.50±0.20	6.37±0.55	6.12±0.23	5.37±0.62	6.97±0.31	5.75±0.69
AST (IU/lit)	A	78.50±1.89	154.65±3.88**	169.50±4.59**	185.50±4.42**	186.50±3.20**	197.00±0.00**
	B	75.00±2.80	68.66±2.59	70.00±5.01	86.66±3.77	80.33±5.66	81.38±1.86
ALT (IU/lit)	A	59.33±1.88	94.00±2.41**	112.00±2.56**	141.00±3.22**	138.00±2.44**	150.00±0.00**
	B	58.75±2.80	55.00±3.08	46.75±2.86	52.00±1.41	49.00±1.87	53.00±1.77
Alkaline Phosphatase (Kind and King units/dl)	A	7.16±0.64	21.04±1.30**	34.79±2.79**	42.43±2.04**	43.40±0.95**	48.75±0.00**
	B	6.87±0.59	5.93±0.48	7.43±0.39	8.31±0.76	7.93±0.43	6.65±0.80

A = Experimentally induced group. * $P < 0.05$.
B = Healthy control group. ** $P < 0.01$.

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