ORIGINAL ARTICLES

ACUTE RENAL FAILURE IN ASPHYXIATED NEWBORNS

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ABSTRACT

The study was undertaken to evaluate the occurrence of renal failure following perinatal asphyxia in the newborns. Thirty newborn with severe birth asphyxia were included in the study alongwith 30 normal newborns who comprised the control group. Any neonate presenting with oliguria or blood urea more than 40 mg/dl or creatinine more than 1 mg/dl was subjected to a fluid and diuretic challenge. If oliguria or renal dysfunction persisted then the child was labelled as renal failure and these subjects were further investigated. It was observed that 43% of asphyxiated babies developed acute renal failure (ARF); 69.2% babies had oliguric renal failure. While no significant correlation could be seen between Apgar scores at 5 and 10 min and development of ARF, a significant relationship was seen between hypoxic-ischemic encephalopathy and ARF. Patients with oliguric ARF carried a poorer prognosis as compared to non-oliguric ARF.

Key words: *Acute renal failure, Oliguria, Birth asphyxia.*

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With an improved survival of sick neonates due to advances in medical care, the clinical entity of acute renal failure is being increasingly recognized. In India where perinatal asphyxia is an important cause of morbidity and mortality it is pertinent to have a high degree of clinical suspicion for early diagnosis and management of acute renal failure.

There is a paucity of literature in India regarding ARF in newborns. The present study was carried out to evaluate the occurrence of renal failure following birth asphyxia and the importance of monitoring renal functions routinely in all such cases.

Material and Methods

This study was conducted in the Neonatal division of Kalawati Saran Children's Hospital, New Delhi during the period July, 1987 to March, 1988. Sixty neonates delivered in the hospital were studied. They were divided into Group I, which consisted of 30 babies who had suffered severe birth asphyxia *i.e.,* an Apgar Score of 3 or less which had been scored by a pediatric resident. Group II comprised 30 babies which formed the control group. These babies were delivered by elective cesarean sections. Babies in both groups were selected by random sampling method and were term infants with comparable weights. Only male babies were included in the study to circumvent technical difficulties in collection of urine in female babies. Babies with septicemia were excluded from the study.

Detailed clinical examination of the baby was done to exclude any congenital anomaly especially of the urinary tract. The

following renal function tests were carried out in all cases first at the time of admission, then at 72 hours of age and finally after 1 week: (*a*) blood urea, (*b*) creatinine, and (*c*) urine output record/24h.

Any neonate presenting with oliguria (urine output <1 ml/kg/h), blood urea more than 40 mg/dl or creatinine more than 1 mg/dl was subjected to an intravenous fluid challenge of 20 ml/kg N/4 saline with 5% dextrose over 1-2 h. If oliguria persisted after 30 min of infusion, intravenous furosemide 2 mg/kg body weight was given. If oliguria still persisted and the renal function was deranged then the infant was diagnosed as acute renal failure(1,2). Further investigation included 24 h urine collection through condom drainage, urine analysis and microscopic examination, blood gas analysis, serum electrolytes, ultra-sonography to rule out congenital or obstructive lesions of the urinary tract. Renal biopsy was done whenever possible.

Serum creatinine was measured by modified method of Jaffe. The blood urea was estimated by modified method of diacetyl monoxime by Wybenga(3,4). Urine output, blood urea and creatinine were monitored daily. The babies were said to be in shock when clinically the peripheral circulation was poor and the systolic blood pressure was <50 mm of Hg(5). All babies with blood pH <7.3 and bicarbonate <18 mEq/L were defined as acidotic(6). The results were tabulated and analyzed using 't'-test and chi-square tests. All babies who developed renal failure were managed conservatively. The babies were on fluid, sodium and protein restriction. None of the babies was dialysed.

Results

In the control group (Group II), the urine output on the first day, third day and seventh day was observed. On the Ist day the urine output ranged between 0.3-1.8 ml/kg/h, averaging 1.0 ml/kg/h while on day 3 and 7 it averaged 1.4 and 1.6 ml/kg/h, respectively. Thus there was a gradual increase in mean output from day 1 to day 7 although the increase was not statistically significant ($p > 0.05$).

Similarly, no significant change was observed in the blood urea levels at different ages ($p > 0.05$). The mean blood urea on days 1, 3, 7 was 25.2, 25.6 and 25.1 mg/dl, respectively. The mean serum creatinine level on days 1, 3, 7 was same being 0.9 mg/dl respectively. There was a gradual fall in the serum creatinine levels although it was not statistically significant.

Renal Failure

Thirteen babies (43.3%) in the asphyxia group (Group I) developed acute renal failure, seven on the first day and 6 on the third day. None of the babies developed hypertension. None of the babies in the control group developed ARF. The incidence of ARF in asphyxiated infants was significantly higher than in the control group ($p < 0.05$). It was further observed that of 13 babies developing renal failure, 9 babies (69.2%) were oliguric while 4 babies (30.8%) were non-oliguric. Duration of oliguria ranged between 1-6 days (mean duration being 2.8 days).

In 13 babies who had renal failure, peak blood urea levels showed a range of 50 to 184 mg/dl (the mean being 94.15 ± 32.7 mg/dl). The mean creatinine level was 1.58 ± 0.58 mg/dl (the range was between 1.0 to 3.2 mg/dl). Two patients had peak serum creatinine levels of 1.0 mg/dl but were labelled as renal failure considering the rising blood urea levels and oliguria. Five patients were found to be acidotic. Only 3 patients had hyponatremia and

1 suffered from hypokalemia. The routine urine examination was normal.

Out of 12 asphyxiated babies who developed shock, 8 babies (66.6%) had ARF, while of remaining 18 babies in Group I, 5 developed ARF (27.7%). Thus the incidence of ARF in patients with shock was significantly higher ($p < 0.05$).

No definite relationship could be shown between Apgar score at 1, 5 and 10 minutes and the development of ARF. It was observed that at 1 minute all the 30 neonates had an Apgar score of 3 or less and 43% of these developed ARF. At 5 minutes, 10 cases had this score and 5 of them (50%) developed ARF. Of the 2 cases who had an Apgar of 3 or less at 10 minutes, 1 (50%) developed ARF (*Table I*).

Table I depicts the correlation of Sarnat hypoxic ischemic encephalopathy (HIE)(7) and ARF. In Grade 0 and Grade I HIE, the number of cases developing ARF was comparable. Similarly in Grades II and III the incidence of ARF was comparable. There was a significantly higher incidence of ARF in Grades II and III as compared to Grades 0 and I ($p < 0.05$).

TABLE I—*Correlation of ARF with Apgar Score and Hypoxic-Ischemic Encephalopathy*

Group	No. of cases	ARF No. (%)
Apgar Score (< 4)		
1 min	30	13 (43.3)
5 min	10	5 (50.0)
10 Min	2	1 (50.0)
HIE (Sarnat staging)		
No encephalopathy	8	2 (25.0)
Grade I	6	1 (16.6)
Grade II	7	5 (71.4)
Grade III	9	5 (55.5)

No significant difference between the mortality in ARF and non-ARF patients was observed. The exact cause of death was difficult to ascertain since autopsies were not carried out. The deaths in each of the groups could be attributed to hypoxic ischemic encephalopathy, shock and renal failure. The mortality in cases with oliguric ARF was significantly higher than in non-oliguric ARF ($p < 0.01$). (*Table II*).

TABLE II—*Mortality Pattern in Neonates with Asphyxia and ARF*

Group	No. (%) of deaths	Significance
1. *Asphyxia* (n=30)		
(*a*) ARF (n=13)	8 (61.5)	>0.05
(*b*) Non ARF (n=17)	8 (47.1)	
2. *Asphyxia with* ARF (n=13)		
(*a*) Oliguric (n=9)	7 (77.7)	$p < 0.01$
(*b*) Non-oliguric (n=4)	1 (25.0)	

Of 8 postmortem renal biopsies done, six showed changes of acute tubular necrosis, *i.e.*, pale cortex, interstitial edema, swollen pale tubular cells with loss of nuclei, one biopsy showed cloudy swelling and the biopsy was normal in one.

Discussion

Perinatal asphyxia producing ischemia is one of the major causes of neonatal renal failure(8). All difficult deliveries requiring resuscitation at birth cause an initial episode of shock and renal ischemia which triggers a transient ischemic state of the kidneys(9). The kidney is very sensitive to oxygen deprivation and within 24 hours of the ischemic episode, renal insufficiency occurs(7).

In the present study, 43.3% of the patients with asphyxia developed ARF. This compared well with a study by Mathew *et al.*(10) and Chevalier *et al.*(11) where 38% and 56% neonates, respectively developed ARF. Anand *et al.* studied 14 patients with ARF and in all patients ARF was due to a major perinatal insult *e.g.,* asphyxia, meconium aspiration(12). Jones *et al.* studied 32 neonates of which 20 developed acute tubular necrosis as a result of perinatal asphyxia, hypoxemia and shock(13).

ARF in this study was predominantly oliguric. This compared well with the other study(12,14).

No definite association was found between Apgar scores at 1, 5 and 10 min with ARF (*Table I*). On the other hand when neurological status of the baby was assessed at birth it was found that greater the degree of neurological insult and ischemic encephalopathy, higher was the ischemic damage to the kidneys reflected as ARF.

In the present study, the mortality rate of ARF in asphyxiated patients was 61.5% while Anand *et al.* and Chevalier *et al.* observed a mortality rate of 35.7 and 25%, respectively(6,9). ARF perhaps does not increase the mortality in an already asphyxiated patient because asphyxia itself is a profound insult to the neonate and ARF additionally does not increase the stress on asphyxiated patient. On the other hand oliguric renal failure carried a poorer prognosis than non-oliguric renal failure ($p < 0.05$) (*Table II*). Mathew *et al.* and Normal and Asadi(10,15) showed a mortality rate of 63% and 43% in their oliguric patients, respectively while Chevalier *et al.* showed a mortality rate of 50% in this group(11). Pathophysiologically non-oliguric renal failure appears to occur because of less severe reduction in GFR and apparent better preservation of tubular function. Whether this simply represents a less severe insult than that producing oliguric renal failure is not certain.

It is recommended that neonates with birth asphyxia and particularly those suffering from hypoxic ischemic encephalopathy, should be screened for renal failure. Such neonates have to be monitored for judicious use of intravenous fluids and correction of acid base imbalance so that they may not require dialysis support.

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