and skeletal abnormalities is described. The association may be due to a new genetic disorder, since 2 similar cases have been reported.

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REFERENCES


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Abnormal renal functions in cyanotic congenital heart disease

Hypoxaemia, secondary polycythemia, and abnormal venous arterial shunts are responsible for several well recognized complications in patients with cyanotic congenital heart disease. These include arterial and venous thromboses, cerebral abscess, bleeding tendency, and growth failure. Giant glomeruli are another well known but as yet unexplained pathological finding in some patients with cyanotic congenital heart disease (Spear, 1960). Since these changes may affect the normal function of the kidney, we have studied several renal functions in children with cyanotic congenital heart disease. This is particularly relevant seeing that major cardiac surgery is now frequently performed on young infants who normally have immature renal function and limited homoeostatic reserve (Edelman and Spitzer, 1969). Also instances of acute renal failure postoperatively are not uncommon (Ogg and Cameron, 1969; Chesney et al., 1975).

Materials and methods

All patients were seen regularly in the cardiac clinic by one of us (A.S.). Diagnosis of the cardiac lesions was confirmed by cardiac catherization and angio-cardiography. None of the patients studied were in congestive heart failure.

Four groups of patients were studied. Group I consisted of 21 patients with Fallot's tetralogy, and one with transposition of the great vessels and arterial septal defect. 3 patients had had a previous palliative shunt operation. The average age was 5-8 years. Group II consisted of 7 patients, who were studied at least 3 months after complete surgical correction of Fallot's tetralogy. 3 of them had been examined before operation. The average age was 7-2 years.

Group III consisted of 5 children with noncyanotic congenital heart disease. The diagnoses in this group were isolated pulmonic stenosis in 2 patients, aortic stenosis in 2, and ventricular septal defect in 1. The average age was 8-0 years. Group IV. The normal controls were 48 children referred to the renal clinic in whom no evidence of disease was found. The average age of this group was 8-8 years.

Renal studies. All the patients studied were on a regular diet. A routine urinalysis was performed on an early morning specimen, which was also examined for the presence of glucose by Clinistest strips and for amino-aciduria by paper chromatography. A 24-hour urine collection was obtained from each patient. The next day timed urine specimens were collected during a forced diuresis producing more than 2 ml of urine per minute. Blood chemistries were determined from a sample of venous blood obtained at the end of the short term urine collections and the creatinine clearance was calculated from these specimens. Blood and urine creatinine concentrations were determined by the alkaline picrate method (Bonsnes and Taussky, 1945). Phosphate, sodium, and uric acid levels in the serum and urine were determined by standard laboratory procedure. The 24-hour urine specimen was used for determining the daily sodium excretion as well as for the calculation of the fractional excretion of uric acid and phosphate. Haemoglobin and haematocrit levels were determined in a Coulter counter.

Results

None of the patients had albuminuria, glucosuria, or aminoaciduria. The urine sediments were normal. The results of the renal functions examined are summarized in the Table. The group with cyanotic congenital heart disease differed signifi-
cantly (analysis of variance, P<0.001) from the other three groups; while neither the patients with noncyanotic heart disease nor the postoperative patients differed from the normal controls. In the 3 patients studied both before and after operation creatinine clearance increased from 43 to 74, 61 to 84, and 78 to 105 ml/min per 1·73 m². The 24-hour sodium excretion was significantly lower (t test P=0·02) in the preoperative cyanotic patients and rose markedly after operation. The mean fractional excretion of phosphate and uric acid were within the normal range.

The Fig. shows the correlation between haematocrit and creatinine clearance in 17 patients with cyanotic congenital heart disease. When the haematocrit values were 50% or less only 3 of the 10 clearances were below 80 ml/min per 1·73 m² and the other 7 were in the normal range. In contrast, all the patients with higher haematocrit values had clearances below 80 ml/min per 1·73 m². This difference is highly significant (Fisher's exact test for 2×2 tables, P=0·006).

**Discussion**

We have shown that glomerular filtration rate as measured by creatinine clearance is decreased in children with cyanotic congenital heart disease and increases to within the normal range after correction of the heart lesion. In unoperated patients there was a significant reduction in glomerular filtration rate when the haematocrit level was above 50%. Similar results have recently been reported in adults with Fallot's tetralogy, all of whom had had a previous shunt operation; however, none were examined after total corrective surgery (Aperia et al., 1974a).

Since a direct relation exists between viscosity of blood and haematocrit levels (Aperia et al., 1974b), the decreased glomerular filtration rate may be explained by an increased viscosity of the blood, which would result in a relatively decreased amount of plasma reaching each nephron. The fact that in some patients, even with haematocrit above 50%, normal creatinine clearance was observed, suggests that factors other than those consequent on polycythemia may exist. The functional significance of anatomic changes of the giant glomeruli seen in some patients with cyanotic congenital heart disease remains speculative.

The normal tubular reabsorption of phosphate and uric acid and the absence of hyperaminoaciduria and glucosuria indicate that no gross defect of proximal tubular function was apparent. Thus the hypoxia in the resting state in these patients does not seem to impair the reabsorptive function of the proximal tubule. The daily sodium excretion in our patients with cyanotic congenital heart disease was decreased. Since no adequate measurement of intake was performed in this study, definite conclusions regarding sodium retention cannot be made. The fact that these patients have a poor appetite and low food intake may explain this finding (Kreiger, 1970); however, Aperia et al. (1974a) have shown sodium retention in adult patients with cyanotic congenital heart disease after

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**TABLE**

**Renal function studies in 4 groups of patients**

<table>
<thead>
<tr>
<th>Group</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Creatinine clearance (ml/min per 1·73 m²)</td>
<td>71·8±18·9</td>
<td>110·2±13·3</td>
<td>97·0±18·7</td>
<td>109·4±14·0</td>
</tr>
<tr>
<td>Urinary sodium excretion (mEq/24 h)</td>
<td>49±33</td>
<td>103±43</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Fractional excretion of phosphate (%)</td>
<td>15·3±9·2</td>
<td>9·9±2·8</td>
<td>8·8±2·5</td>
<td>9·0±2·1</td>
</tr>
<tr>
<td>Fractional excretion of uric acid (%)</td>
<td>14·8±9·3</td>
<td>12·1±2·7</td>
<td>10·4±3·6</td>
<td>8·1±2·0</td>
</tr>
</tbody>
</table>

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**Fig.**—Relation between corrected creatinine clearance and haematocrit in patients with cyanotic congenital heart disease.
a sodium load. Experimental studies support the view that an increased oncotic pressure in the peritubular capillaries, consequent on polycythemia, facilitates increased sodium reabsorption (Schrier and Earley, 1970).

The decreased glomerular filtration rate in patients with cyanotic congenital heart disease and an increasing awareness of the limited homoeostatic capabilities and decreased renal function in infants emphasize the importance of careful monitoring of renal function in these patients, especially in the early postoperative period.

Summary

Children with cyanotic congenital heart disease had a decreased glomerular filtration rate (71.8 ± 18.9 ml/min per 1.73 m²) measured by endogenous creatinine clearances, compared with children who had had complete corrective surgery, children with noncyanotic heart disease, and normal children. There was a significant correlation between low glomerular filtration rate and haematocrit values above 50%. Daily urinary sodium excretion was reduced in the cyanotic patients.

References


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Pulmonary eosinophilic granuloma in a child

While the various forms of histiocytosis X are not particularly uncommon in childhood, it appears to excessively rare for the disease to be localized to the lungs, most patients with isolated lung disease being adults (Lewis, 1964). We report a case of isolated pulmonary eosinophilic granuloma in a 3-year-old child, who presented in the characteristic fashion and who failed to respond to radiotherapy.

Case report

A female born in 1971 of Asian parents had been a healthy child, though small, until the age of 3 years 5 months when she became unwell with nausea and abdominal pain. The pain later shifted to her chest, and by next morning was more severe, associated with shortness of breath. She was referred to hospital where a right pneumothorax was found. A chest drain was inserted with continuous underwater suction. The lung re-expanded but the drain continued to bubble air for a further 15 days. It became apparent on chest x-ray that she had a honeycomb abnormality of both lungs, and she was transferred to Hammersmith Hospital for further investigation.

On examination she appeared unwell, with a chest drain in situ. She was small, height being 91 cm (3rd centile) and weight 8·3 kg (3rd centile). Respiratory rate was 24/min, with no cyanosis, but crepitations were audible at the right lung base and there was clubbing of fingers and toes. There was no significant lymphadenopathy, and no enlargement of liver or spleen. All other systems were normal.

Chest x-ray showed a honeycomb appearance throughout both lungs. Her arterial Pa₂ in air was 84 mmHg, pH 7·39, and PCO₂ 31 mmHg. An adequate sample in oxygen was not obtained. Blood count showed Hb 12·7 g/dl, WBC 12 800/mm³ (12·8·10⁹/l) (neutrophils 92%, lymphocytes 2%, monocytes 6%), erythrocyte sedimentation rate 5 mm/h, Mantoux 1:1000 was negative. A gamma scan of the lungs using radioactive N₂ (Ronchetti et al., 1975) showed poor ventilation of both lungs, right worse than left. Sweat electrolytes were normal and there were no clinical features to suggest epilopa. There was no radiological evidence of bony granulomata as judged by her skeletal survey and skull x-rays, which were normal. There was no clinical or laboratory evidence of diabetes insipidus (urine osmolality 784 Osm/kg after overnight starvation).

The pleural drain was removed, but 2 days later the pneumothorax recurred. The opportunity was taken to treat this surgically, and at the same time to take a lung biopsy. At thoracotomy (Mr. M. P. Singh) the cystic abnormality of the lungs was confirmed. Biopsies were taken from lung and rib and 50% dextrose solution instilled to induce pleural adhesion. She made a satisfactory recovery and the pneumothorax did not recur.