Primary Arteritis of Abdominal Aorta in Children Causing Bilateral Stenosis of Renal Arteries and Hypertension

By T. J. Danaraj, M.D., M.R.C.P.E., and Wong Hee Ong, M.B.

Recent reports1-6 have emphasized the importance of recognition and satisfactory surgical treatment of patients suffering from hypertension due to unilateral renal artery stenosis caused by embolism, thrombosis, atherosclerotic plaques, or aneurysms. Most cases have been in adults and the diagnosis of the obstruction was made by aortography. The purpose of this paper is to draw attention to the occurrence of hypertension in children as a result of stenosis of the orifices of both renal arteries by a localized arteritis of the abdominal aorta. As in adults, aortography would enable the recognition of such lesions and lead to possible surgical cure.

CASE REPORTS

Case 1. A 7-year-old Chinese girl was admitted to the General Hospital, Singapore, on March 21, 1955, because of difficulty in breathing, epigastric discomfort, swelling of the feet, and puffiness of the face. She had been in good health until 3 weeks previously when attacks of breathlessness and discomfort in the epigastrium occurred and became progressively worse. Swelling of the feet, diminished urinary output, and slight puffiness of the face occurred 1 week before admission. There were no general symptoms or history of recent sore throat or any other infection.

Physical examination revealed a very sick girl, with pale and slightly puffy face, engorged neck veins, dyspnea, and restlessness. There was no fever. The pulse rate was 112 per minute. There was slight pitting edema of the feet, and a forceful apical beat was felt in the fifth left intercostal space 10 cm. from the midsternal line. The second sound in the pulmonic area was louder than the second aortic sound. Gallop rhythm and a soft systolic murmur of moderate intensity were heard in the mitral area. The blood pressure was 125/110 mm. Hg and equal in both arms; the arterial pulses in the lower extremities were distinctly palpable. The fundi were normal.

Examination of the lungs revealed normal findings. The liver was enlarged 4 fingerbreadths below the costal margin and was tender; the spleen and kidneys were not felt.

The hemoglobin was 9.6 Gm. per 100 ml., the erythrocyte count was 3,370,000, and the leucocyte count was 13,000 per mm.2 with a differential count of 78 per cent polymorphonuclear cells, 20 per cent lymphocytes, and 2 per cent monocytes. The plasma proteins were 4.67 Gm. per 100 ml.; albumin 3.16, globulin 1.35, and fibrinogen 0.18 Gm. per cent. Examination of urine revealed a specific gravity of 1.010, 1+ albumin, and a few pus, red blood, and epithelial cells per high-power field; a few granular casts were also present. An x-ray film of the chest showed an enlarged heart, with congestion of the lungs.

The clinical course was characterized by a persistently elevated blood pressure (140 to 110 over 115 to 90 mm. Hg) and intractable cardiac failure. Response to treatment with digitalis was poor and complicated by numerous ventricular extrasystoles. Injections of mersalyl produced no significant diuresis. The urinary output varied between 15 and 25 ounces a day, the specific gravity of the urine being between 1.006 and 1.012; no albumin was found nor were casts seen in centrifuged deposits. Frequent estimations of the blood urea gave normal levels until 5 days before death, when it was 46 mg. per 100 ml.

Puffiness of the face disappeared, but slight edema of the feet persisted. A second radiologic examination of the chest showed a further increase of the cardiac shadow and persistent pulmonary congestion. She died 46 days after admission to the hospital.

At necropsy the heart was enlarged with hypertrophy and dilatation of the left ventricle. The endocardium was smooth, and there was a small adherent thrombus below the anterior cusp of the aortic valve; there were no valvular defects. The
coronary arteries were smooth and of normal caliber. On the intimal surface of the aorta were 3 strictly localized plaques of thickened intima (figs. 1 and 2). The first, situated just above the posterior cusp of the aortic valve, was 1 by 0.5 cm. in diameter. The second, on the arch of the aorta just distal to the origin of the left subelavian artery, was 2 by 3 cm. and had a red thrombus superimposed on it, while the third and largest involved the entire circumference of the abdominal aorta, extending from the origin of the celiac artery to just below the level of the ostia of the renal arteries. The affected area measured 3.5 cm. in length and was covered by large adherent red thrombi that had occluded the orifice of the superior mesenteric artery. The ostia of the celiac artery and both renal arteries were considerably narrowed by the thickened intima and obscured by the thrombi. The arteries themselves were of normal caliber and showed no abnormality. The rest of the aorta was normal.

Both suprarenal glands and left kidney were normal. There was a depressed scarred area on the convex border of the posterior surface of the right kidney, which was slightly smaller than the left. The lungs were edematous and congested. The liver was enlarged and firm, and its cut surface exhibited the characteristic appearance of chronic venous congestion. The spleen was normal in size, but congested. The other organs showed no changes. The skull was not opened.

The histologic appearance of sections of the left ventricle were those of hyperplasia and hypertrophy of the myocardium. A small adherent thrombus was present on the endocardial surface below the aortic valve (fig. 3). There was no thickening of the endocardium or inflammation or fibrosis of the myocardium. Sections of the aorta (fig. 4) taken from the areas of the 3 plaques showed marked thickening of the intima with areas of ulceration and thrombus formation. The intima consisted of loose connective tissue with areas of hyalinization in the deeper layers and organization of the thrombi on the surface. The media showed fairly well marked vascularization and patchy areas of destruction with replacement by collagen. Necrosis of the media was most marked in those areas where there was ulceration of the overlying intima. Focal infiltration of the media and adventitia mostly by lymphocytes, but also by some plasma cells was a chief feature; these cells were mainly perivascular in distribution (fig. 5). The adventitia was thickened, with increased vascularization, but endarteritis was not present. These pathologic changes although involving the aorta adjacent to the ostia of the renal, superior mesenteric, and celiac arteries, had not extended into the arteries themselves. No orga-

nisms were seen. Sections of the renal arteries and of the aorta between the 3 plaques revealed no abnormality.

Except for multiple infarcts situated mainly in the cortex of the right kidney, there were no abnormalities in either kidney. The intrarenal arteries showed no hypertrophy or degenerative changes and there was no proliferation of the intima. The histologic changes found in the spleen and liver were those of chronic venous congestion.

Case 2. A Chinese boy aged 13 years was hospitalized because of increasing drowsiness and fits. He was well until 3 months prior to admission, when he developed a low-grade irregular fever and cough. On the day of admission he was found to be drowsy and had twitchings of the face and mouth, with clonic movements of all limbs.

On examination the boy was unconscious and having generalized fits; the temperature was 101 F., the pulse rate 100, and the respiratory rate 32 per minute.

The heart was enlarged to the left, with a forceful apical beat in the sixth left intercostal space in the anterior axillary line. The second sound in the aortic area was loud and ringing; there were no murmurs. The blood pressure was 160/120 mm. Hg in both arms; the femoral pulses were easily felt. The lungs were clear, and the liver, spleen, and kidneys were not palpable. The neck was rigid, and a positive Kernig sign was elicited. The limbs were flaccid, with absent tendon reflexes.
and bilateral Babinski response. The pupils were dilated and nonreactive, and examination of the fundi showed no abnormality.

The hemoglobin was 10.9 Gm. per 100 ml. and the leukocyte count was 18,400 per mm.\(^3\) with 86 per cent polymorphonuclear cells. Examination of the blood urea was 55 mg. per 100 ml.; blood culture and a Kahn test were negative. The urine, which had a specific gravity of 1.015, contained 1+ albumin and few red blood cells and pus cells per high-power field.

The patient was treated as for hypertensive encephalopathy and also given penicillin. He became less drowsy, regained consciousness, and on the fifth day his temperature became normal.

Repeated urinalyses revealed in the centrifuged deposit about 60 to 70 red blood cells per field with occasional pus cells and granular casts; the specific gravity was normal. Escherichia coli were cultured from the urine once. Radiologic examination revealed an enlarged heart with a prominent left ventricle and congestion of the lungs. There was no appreciable difference in the size of the kidneys and intravenous pyelograms were normal. A Regitine test was negative. The hypertension persisted, varying between 130 to 190 mm. Hg over 120 to 150 mm. Hg. After 18 days congestive cardiac failure appeared and 4 days later the patient died.

At necropsy the heart was enlarged and the left ventricle markedly hypertrophied. The endocardium was smooth and not thickened, but below the aortic valve there was a small adherent thrombus. The valves showed no abnormality. The aortic arch and descending thoracic aorta were of normal caliber, and the intima was smooth and glistening except for a few small flecks of atheroma around the orifices of the branches of the arch. The abdominal aorta was normal except for a clearly demarcated area 8.5 cm. long extending from 1 cm. above the origin of the celiac artery to just above the origin of the inferior mesenteric artery (fig. 6). This segment of the aorta was uniformly dilated and its intimal surface presented a swollen appearance with irregular raised plaques, some of which had ulcerated, with formation of adherent thrombi. The origin of both renal arteries was involved in this pathologic process resulting in considerable narrowing of the left ostium and occlusion of the right (fig. 7). The right renal artery, which was larger than the left and felt like a cord, contained a thrombus extending from the aortic orifice of the artery along its entire course up to its bifurcation at the hilum of the kidney. The ostium of the left renal artery presented a small slit-like appearance due to swelling and puckering of the adjacent intima; the lumen of the artery along its entire length contained a slender

![Fig. 2. Case 1. Abdominal aorta with third plaque. The overlying thrombi obscure the orifices of the renal arteries. Depressed scar on posterior surface of right kidney, which is slightly smaller than left.](http://circ.ahajournals.org/)

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thrombus that only partially obstructed it. The intimal surface of both renal arteries was smooth and showed no changes. The orifice of the celiac artery was completely obliterated while that of the superior mesenteric artery was narrowed. The origin of the inferior mesenteric artery was unaffected. A localized cylindrical dilatation about 2 cm. long, of the innominate artery, was present 1 cm. from its origin. The intima of the artery at this site was raised and thickened, without any ulceration or thrombi on its surface. Elsewhere in the innominate artery and also in the left common carotid and left subclavian were a few flecks of atheroma. The coronary arteries were patent and the intima smooth except for a few atheromatous flecks on the intimal surface of the right coronary.

The right kidney was slightly smaller than the left. The capsules stripped easily, the surfaces being smooth except for a moderately large wedge-shaped depressed scar on the posterior surface of the right kidney. The cut surfaces revealed normal calyces.

The lungs, liver, and spleen were congested. The brain was edematous and pale; over the dorsal surfaces of the occipital poles of both cerebral hemispheres in the subdural space were some old blood clots that caused a yellow staining of the underlying brain tissue. There was no hemorrhage into the brain substance and the cerebral arteries were normal.

Histologic examination of sections of the left ventricle revealed hyperplasia and hypertrophy of the muscle fibers. A small adherent thrombus was present on the endocardial surface below the aortic valve. There was no thickening of the endocardium or evidence of inflammation or fibrosis of the myocardium. In the abdominal aorta, at the level of the renal arteries, were irregular areas of intimal thickening due to fibroblastic proliferation together with deposition of homogeneous hyaline substance with some "lipid" clefts in the subintimal layer. There was ulceration of the surface of the intima with thrombosis formation and organization of some of the thrombi. Patchy destruction of the elastic tissue of the media (fig. 8) had occurred and increased vascularity with infiltration by some lymphocytes and plasma cells was evident. The adventitia was thickened and showed an increased number of capillaries with round-cell infiltration. Sections of the innominate artery (fig. 9) exhibited similar changes except that there was no ulceration of the intimal surface. The walls of the renal arteries were normal except for a minimal round-cell infiltration of the right renal artery, which was probably a nonspecific reaction to the extensive thrombosis of this artery.

There was a large area of infarction in the right kidney (fig. 10) showing coagulation necrosis and marginal hemorrhage together with similar smaller areas. The rest of the kidney tissue and sections of the left kidney revealed no abnormality of the intrarenal vessels or renal parenchyma.

**Discussion**

Both these children presented clinical problems as to the cause of their hypertension. The possibility of glomerulonephritis was consid-
The essential pathologic lesion in each patient was a panarteritis affecting a localized area of the abdominal aorta and resulting in stenosis of the visceral arteries (celiac, superior mesenteric, and renal) arising from the aorta at this level. Destruction of the media was extensive and in the second patient had caused dilatation of the involved portions of the aorta and innominate artery. The marked intimal hyperplasia, with thrombosis, was probably secondary to the changes in the media. There was no evidence of renal parenchymal disease and the absence of any arteriolar lesions in either kidney suggested that they had been protected from the impact of the hypertension by the occlusion of the renal arteries. In the absence at necropsy of any other ascertainable cause for the hypertension, it is safe to assume that the rise of blood pressure was due to partial obstruction of arterial blood flow to both kidneys, produc-
ing a clinical equivalent of the 'Goldblatt kidney.'

Reports of bilateral stenosis of the renal arteries with resultant hypertension are rare. Most of the cases have occurred in older adults, the commonest lesion being atherosclerosis of the abdominal aorta with occlusion of the renal artery orifices by atheromatous plaques or an aortic thrombus.7-12 Endarterectomy done in some of these cases resulted in a fall of blood pressure. Other lesions have sometimes been encountered in relatively younger age groups: renal arteritis due to syphilis in a 24-year-old woman,13 nodules of hyperplastic intima occluding the renal artery orifices in a 27-year-old woman,14 and a thromboaortic plaque superimposed on an undetermined meso-aortitis in a 32-year-old woman.15 In the last 2 patients, the pathologic lesions were localized to the abdominal aorta at the level of the origin of the renal arteries.

Hypertensive disease in childhood due to stenosis of both renal arteries has been only rarely recorded. In a male infant who died of hypertensive cardiac failure, Dawson and Nabarro16 found narrowing of the renal arteries due to intimal hyperplasia; similar histologic changes were found in the coronary arteries and the authors suggested that the condition may have been one of healed polyarteritis nodosa. In a boy aged 14 years, who died of cerebral hemorrhage, Fisher and Corcoran17 noted severe stenosis of the orifices of both renal arteries, the superior mesenteric artery, and the celiac artery caused by changes in the abdominal aorta consisting of fibrous proliferation of the intima with islands of lipophage infiltration. Poutasse and others18 demonstrated, by aortography, stenosis of the origins of both renal arteries in a 15-year-old boy with hypertension. Histologic examination of the renal arteries, which were excised and replaced by arterial grafts, showed narrowing of the lumen by fibrous intimal hyperplasia: the blood pressure became normal following the operation.

The pathologic lesions found in the cases recorded above are not comparable to those found in the 2 children reported in this paper in whom the segmental distribution suggested an infective embolic process. No foci of sepsis were found at necropsy, however, and no organisms were demonstrated in sections of the affected portions of the vessels. Syphilis was considered, but the age of the patients, the negative serologic test (in case 2), and the gross appearance of the lesions, which were
focal rather than diffuse, excluded this possibility.

The lesions, however, bear a striking resemblance to those described as occurring in a now more widely recognized clinicopathologic entity of unknown etiology called variously pulseless disease, Takayasu's syndrome, arteritis, brachiocephalic arteritis, aortic arch arteritis, or primary arteritis of the aortic arch. The essential lesion in this group of cases is a chronic progressive panarteritis of the aorta and the proximal segments of the arteries arising from the arch resulting in partial or complete thrombotic obliteration of their lumen. Although classically the arteritis is limited to the aortic arch, reports indicate that the descending thoracic and abdominal aorta and the mesenteric and renal arteries may also be affected. It is therefore possible, in primary arteritis of the aorta, for the proximal segments of the visceral branches, such as the coronary, the mesenteric, and the renal arteries, to be involved in the pathologic process. The clinical presentation in such patients would therefore differ from the more usual one resulting from obstruction of the common carotid arteries. In a 40-year-old woman who had been observed as a case of Takayasu's syndrome by Ask-Upmark and Fajers for many years, death occurred from uremia due to thrombotic obstruction of the aortic origins of the renal arteries resulting in a reduced blood supply to the kidneys. Histologic examination revealed a panarteritis with secondary arteriosclerotic changes involving the entire aorta, while the proximal portions of the branches of the aortic arch showed a similar type of arteritis with thrombotic occlusion of their lumina. The unusual location of the arteritis at the level of the origin of the renal arteries in the 2 patients reported in this paper resulted in the atypical presentation of renal hypertension. The adjoining visceral branches of the aorta, viz., the celiac and superior mesenteric arteries were also occluded.

The successful surgical treatment of hypertension due to obstructive lesions of both renal arteries makes diagnosis important, but this is difficult because urinalysis, renal function studies, and intravenous and retrograde pyelography are frequently normal, as stressed by Poutasse and Dustan and De-Camp and Birchall. These authors, therefore, consider abdominal aortography essential for the diagnosis of renal arterial lesions and indicated in all young patients with no family history of and no apparent cause for hypertension. The diagnosis of "essential hypertension" in children, made in some instances in the past, would not be tenable unless adequate renal arterial flow was demonstrated by this investigation.

**Summary**

In 2 children with hypertension, necropsy revealed a localized arteritis of the abdominal aorta that had resulted in occlusion of the renal artery orifices to produce the clinical equivalent of the "Goldblatt kidney." The histologic appearance of panarteritis suggests the possibility that these cases are variants of the disease called primary arteritis of the aortic arch or Takayasu's syndrome. The importance of diagnosis by means of aortography in view of possible surgical cure is stressed.

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**Sommario in Interlingua**

In 2 patientes pediatric con hypertension, le necropsia revelava un aortitis localisate del aorta abdominal que hebave resultate in occlusion del orificios reno-arterial e le production del equivalente clinic de "ren de Goldblatt." Le apparentia histologic de panarteritis suggere le possibilitate e que iste cases representa variantes del morbo designate como arteritis primari del arco aortic o syndrome de Takayasu. Es signalate le importantia de establir le diagnose per medio de aortographia con le objectivo de effectuar possibilemente un curacion chirurgie.
REFERENCES

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