

Effect of kwashiorkor on the cardiovascular system

J W BERGMAN, D G HUMAN, M M A DE MOOR, AND J M SCHULZ

Cardiology Unit, Department of Paediatrics and Child Health, University of Cape Town, Red Cross War Memorial Children's Hospital, South Africa

SUMMARY In kwashiorkor the heart is clinically and radiologically small. This study utilises echocardiography, a tool not previously used in this disease, to show that this is due to decreased muscle mass.

Malnutrition stunts growth and produces generalised tissue wasting, particularly a severe loss of muscle tissue and protein, which almost certainly includes the heart muscle. The syndrome of kwashiorkor (protein energy malnutrition) is characterised by oedema, as well as tissue loss, skin, hair, and mood abnormalities.¹ Various cardiovascular abnormalities have also been documented, including low cardiac output,^{2,3} cardiac failure (reduced cardiac size),⁴ and sudden unexpected death.⁵

This study was undertaken to assess both wall and chamber size as well as function of the left ventricle in children with kwashiorkor, utilising echocardiography as an entirely non-invasive and accurate tool not available to the earlier investigators cited above.

Patients and methods

All patients with the clinical features of kwashiorkor admitted to the Red Cross War Memorial Children's Hospital were screened and in the absence of severe, dehydrating diarrhoeal disease, septicaemia, or pre-existing cardiac disease were considered for the study.

Initial investigations included measuring plasma proteins and haemoglobin concentrations. Patients were only included in the study if serum albumin concentration was less than 25 g/l, confirming severe protein lack, and the haemoglobin concentration more than 70 g/l, thus excluding the cardiovascular effects of severe anaemia. Over a six month period, 21 patients aged 12 to 30 months underwent chest radiography, electrocardiography, and echocardiography within 48 hours of admission.

The cardiothoracic ratio was determined from the chest radiograph (broadest diameter of the heart internal diameter of the chest). From standard 12 lead electrocardiograms the R wave amplitude in

lead V6 was measured and compared with percentile charts.⁶ The QT interval was also measured and corrected for rate by applying Bazett's formula ($QT \text{ interval} \sqrt{RR \text{ interval}}$).⁷

Cross sectional and M mode echocardiography was performed on an Advanced Technology Laboratories Mark 300C machine. The M mode recordings were checked by two observers, and all measurements were made according to the American Society of Echocardiography standards.⁸ Direct measurement was made of the left ventricular dimension at end systole (LVES) and end diastole (LVED), and left ventricular wall thickness from the widths of the interventricular septum and the posterior left ventricular wall. These values were compared with percentile charts,⁹ and derived values for left ventricular function were obtained from the formula: shortening fraction = $\frac{LVED - LVES}{LVED}$ respectively.

Results

All 21 patients had chest radiography. The cardiothoracic ratio was below 60% in all. Twenty out of 21 (95%) had ratios less than 55%; 14 of the 21 had values less than 49%. Nineteen patients had electrocardiography; the QTc was normal in all. The amplitude of the R wave in V6 was less than the 25th centile (as compared with age related centiles) in 18 (95%) of patients,⁶ and less than the 5th centile in seven (37%). Twenty of the 21 patients had values within the 95% predictive values for the left ventricular end diastolic dimension for body surface area (fig 1). Eighteen of the 21 patients were within the predictive values for the end systolic dimension (fig 2). Overall 19 (90%) had values above the 5th centile for body surface area.

As regards the ventricular wall measurements 17 (81%) patients had values below the 5th centile for

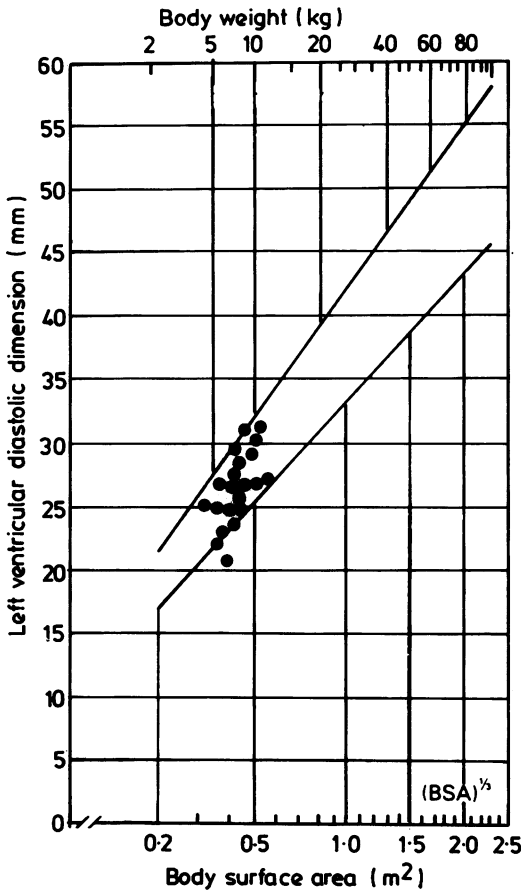


Fig 1 Left ventricular diastolic dimension according to body surface area with the 95% prediction intervals drawn for assessment.⁹

the interventricular septal measurement (fig 3) and 15 (71%) for the posterior wall (fig 4). Overall 16 (76%) had values equal to or below the 5th centile for one or both variables. Twenty patients had normal contractility as measured by the shortening fraction—that is, a value of 30% (mean=38%). One patient had a shortening fraction of 25%.

Discussion

This study has shed new light on some unanswered questions on the cardiovascular consequences of kwashiorkor. The presence of a small heart, in the early stages of the illness, has been confirmed, and the cause of this lies in decreased myocardial tissue. The septal thickness or left ventricular posterior wall thickness, or both were below 5th centile lines in

74% of patients, whereas the left ventricular chamber dimensions were above the 5th centile lines in 90%. This is in accord with postmortem studies showing very low cardiac mass.⁵ Left ventricular function is initially well preserved despite the loss of myocardial tissue, and the shortening fraction was above 0.30 in all but one patient. At presentation, impaired contractility is thus not a cause of low cardiac output, and the results obtained from dye dilution studies³ may have been confounded by other variables—for example, leakage of dye out of the intravascular compartment and excessive dilution of dye due to anaemia in the early stages.

Decreased muscle mass at initial presentation may be the cause of later cardiomegaly and cardiac

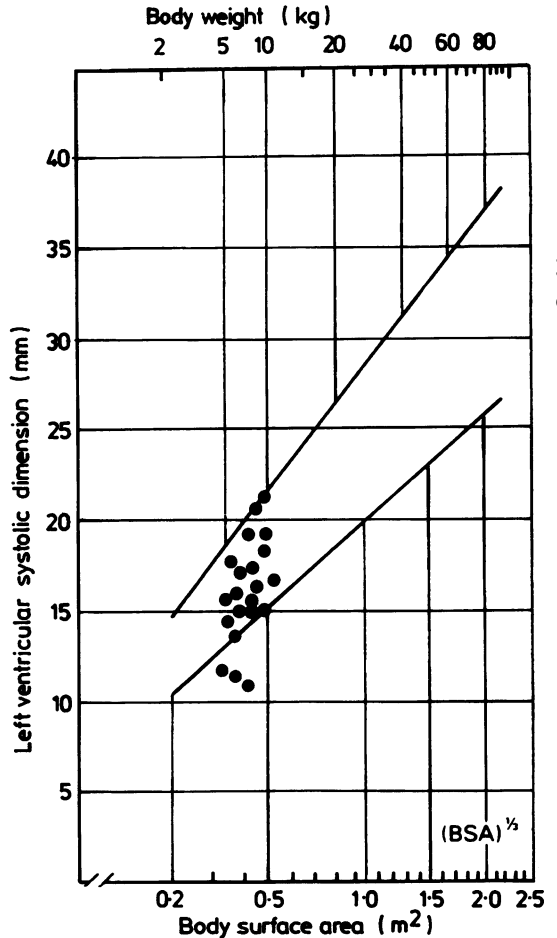


Fig 2 Left ventricular systolic dimension according to body surface area with the 95% prediction intervals drawn for assessment.⁹

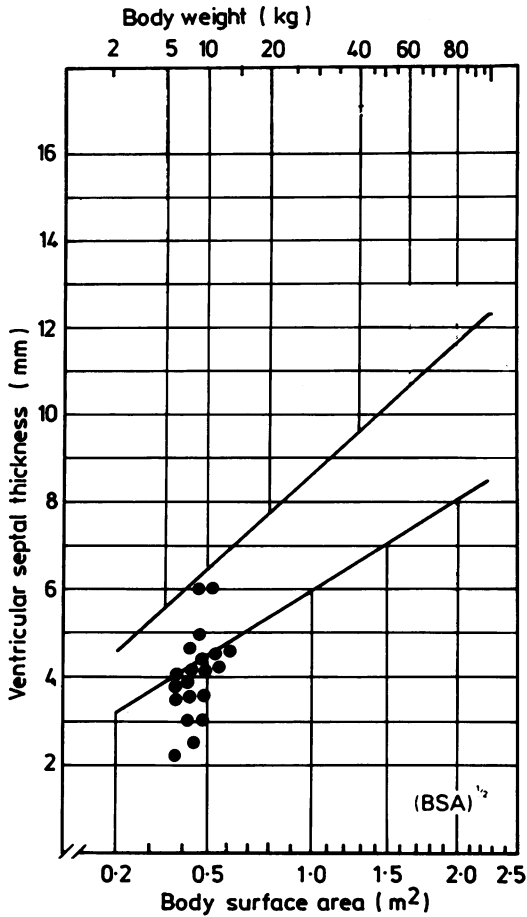


Fig 3 Ventricular septal thickness according to body surface area with the 95% prediction intervals drawn for assessment.⁹

failure in the refeeding stage,¹⁰ as the left ventricle may not be able to respond to increases in left ventricular preload, especially with inappropriate salt loading.⁴

Sudden cardiac death also occurs during refeeding and some histological studies have shown structural breakdown of myocardial elements during starvation.^{11 12} Arrhythmias have been implicated as a cause for sudden death during refeeding. Prolongation of the QT interval was well documented by Smythe *et al*,⁵ but they could not show this consistently in their patients who subsequently died. More recent studies in fasting adults have confirmed this observation, and further implicated QT prolongation as a factor in sudden death.¹³ No abnormal QT intervals were recorded in this study, but all electrocardio-

grams were obtained on admission and not during the refeeding stage.

A recent study that compared subjects with kwashiorkor with age matched controls confirms our findings of reduced myocardial mass with preserved left ventricular function.¹⁴ We have used standard centile curves, and although there may be racial differences in cardiac dimension (all our patients were black) these are very small in the age range 12 to 30 months.¹⁵

The treatment of kwashiorkor should therefore be directed at gradual correction of fluid, electrolyte, and nutritional disturbance, and early treatment of secondary infections as it appears that although primary myocardial dysfunction is not present, there is a decreased myocardial mass, which may lead to

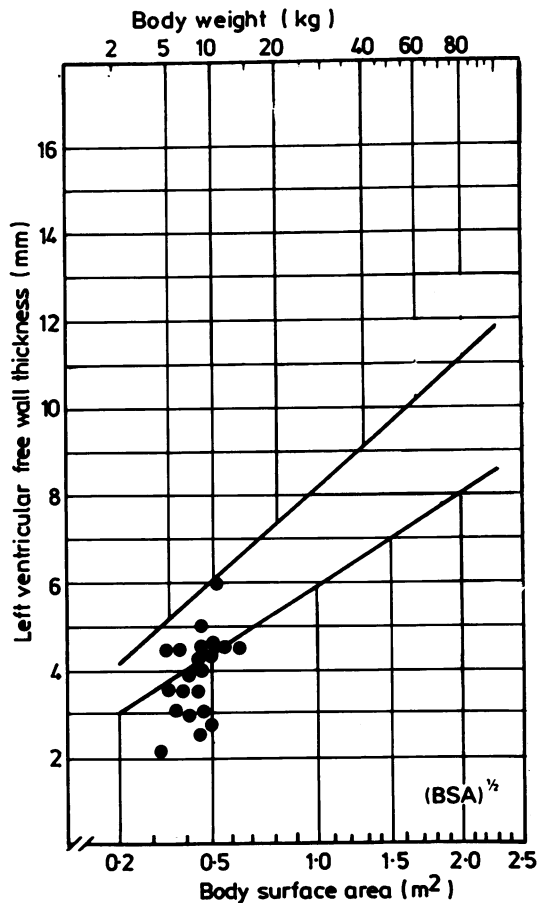


Fig 4 Left ventricular free wall thickness according to body surface area with the 95% prediction intervals drawn for assessment.⁹

an inability of the ventricles to respond to increases in ventricular preload.

Further echocardiographic studies during re-feeding are required to show the left ventricular response to an increased preload in children with kwashiorkor.

We thank Miss K Leahy for secretarial help with the manuscript and the medical superintendent of the Red Cross War Memorial Children's Hospital, Dr RO Simpson, for permission to publish.

References

- ¹ McCance RA. Malnutrition in the children of underdeveloped countries. In: Gairdner D, Hull D, eds. *Recent advances in paediatrics*. 4th ed. London: Churchill, 1971:479–525.
- ² Alleyne GAO. Cardiac function in severely malnourished Jamaican children. *Clin Sci* 1966;**30**:553–5.
- ³ Swanepoel Smythe PM, Campbell JAH. The heart in kwashiorkor. *Am Heart J* 1964;**67**:1–3.
- ⁴ Wharton BA, Howells GR, McCance RA. Cardiac failure in kwashiorkor. *Lancet* 1967;**ii**:384–5.
- ⁵ Smythe PM, Swanepoel A, Campbell JAH. The heart in kwashiorkor. *Br Med J* 1962;**i**:67–73.
- ⁶ Davignon A, Rautarharju P, Boiselle E, Locunuis F, Megelas M, Choquette A. Normal ECG standards for infants and children. *Pediatr Cardiol* 1979;**80**;1:123–31.
- ⁷ Bazett HC. An analysis of the time relations of electrocardiograms. *Heart* 1920;**7**:353–70.
- ⁸ Lahn DJ, De Maria A, Kisslo J, Weyman A. Recommendations regarding quantitation in M-mode echocardiography. *Circulation* 1978;**58**:1072–83.
- ⁹ Henry WL, Gardin JM, Ware JH. Echocardiographic measurements in normal subjects from infancy to old age. *Circulation* 1980;**62**:1054–61.
- ¹⁰ Wharton BA, Balmer SE, Somers E, Templeton AC. The myocardium in kwashiorkor. *Q J Med* 1969;**149**:107–16.
- ¹¹ Garnett ES, Barnard DL, Ford J, Goodbody RA, Woodehouse MA. Gross fragmentation of cardiac myofibrils after therapeutic starvation for obesity. *Lancet* 1969;**i**:914–6.
- ¹² Taylor JR. Fragmentation of myofibrils after starvation. *Lancet* 1969;**i**:1215.
- ¹³ Isner JM, Sours HE, Paris AL, Ferraus VJ, Roberts WC. Sudden, unexpected death in avid dieters using the lipid-protein-modified-fast diet. *Circulation* 1979;**60**:1401–11.
- ¹⁴ Shoukry I, Shoukry AS, Ibrahim MM, Fahmy N, Madkour MA, el Said G. Cardiac atrophy and ventricular function in infants with protein calorie malnutrition. In: Doyle EF, Engle MA, Gersony WM, Rashkind WJ, Talner NS, eds. *Pediatric cardiology*. New York: Springer Verlag, 1986:1169–71.
- ¹⁵ Lester LA, Sodt PC, Hutcheon N, Arcilla RA. M-mode echocardiography in normal children and adolescents: some new perspectives. *Pediatr Cardiol* 1987;**8**:27–33.

Correspondence and requests for reprints to Dr MMA de Moor, Paediatric Cardiology Unit, Red Cross War Memorial Children's Hospital, Rondebosch 7700, Cape Town, South Africa.

Accepted 22 March 1988