Renal-vertebral index in normal children

C BACOPOULOS, MARIA PAPAHAZI-KALMADI, T KARPATIOS, T THOMADIS, AND N MATSANIOTIS

First Department of Paediatrics of Athens University, Aghia Sophia Children's Hospital, Athens, Greece

SUMMARY The renal-vertebral index is a simple method of evaluating the renal length in children and is convenient for everyday clinical work. The results on 822 normal children aged between 3 days and 14 years are reported. Infants of up to 1 year were found to have an index of about 4 to 5, pre-school children an index of $3\frac{1}{2}$ to $4\frac{1}{2}$, and schoolchildren an index of $3\frac{1}{2}$ to 4. There was no significant difference in renal-vertebral index between boys and girls.

Assessment of renal size is of diagnostic and prognostic value.¹⁻³ Conditions—such as polycystic disease, acute glomerulonephritis, acute leukaemia, and renal vein thromboses—cause renal enlargement, while chronic interstitial nephritis and other disorders result in gradual shrinkage of one or both kidneys.⁴ The present study provides a simple and standardised method—the renal-vertebral (R-V) index—for evaluation of renal size in childhood.

Methods

The study material comprised x-ray films taken of 822 children without recognisable renal disease over a 10-year period. The children were aged between 3 days and 14 years; 412 were boys. The length of the kidneys was measured on anteroposterior abdominal roentgenograms exposed at a 40-inch target film distance during intravenous urogram (IVU) with the patient supine. The reason for performing the IVU was mainly unexplained abdominal pain or pyrexia of unknown origin. The children were otherwise well developed and had no chronic disease. In young infants and neonates the reason was generally pyrexia of unknown origin, or an impression of 'not doing well'.

The children (and IVU) fulfilled the following criteria: (a) history free from known renal disease, (b) normal blood pressure, (c) normal excretory urinary tract system, (d) normal blood urea or normal serum creatinine, (e) normal midstream urine examination and culture, (f) sufficiently clear outline of both kidneys (nephrogram).

The length of each kidney was estimated by measuring the maximum distance from the cephalad to the caudal margin (Fig. 1). The best film of the IVU was chosen on each occasion, but in many

instances it was necessary to study all the films of the IVU for the best determination of the renal outline.

The number of vertebral bodies and their discs which comprised the maximal length of each kidney was estimated counting from the upper border of the 12th thoracic vertebra. The end point was estimated to the closest quarter of the length of the last corresponding vertebra plus its disc. This number was called the R-V index. For example, the R-V index of a kidney is 4, if its length corresponds exactly to the distance from the upper border of T12 to the upper border of L4 (Fig. 1); we define the R-V index at $4\frac{1}{4}$, if the kidney length corresponds to the top of T12 to a point close to $\frac{1}{4}$ of the distance between the top of L4 and the top of L5.

Fig. 1 Estimation of renal-vertebral index; AB= kidney length, C=upper lip of 12th thoracic body, CD=renal-vertebral index (in this case 4).

Table Renal-vertebral index in 822 normal children (boys and girls)

Age (years)	Number of children	Renal-vertebral index
0-0.5	133	$\bar{x} \pm 2 \text{ SD} = 4.7 \pm 0.6$
0.5-1	136	$\bar{x} \pm 2 \text{ SD} = 4.5 \pm 0.6$
1-2	117	$\bar{x} \pm 2 \text{ SD} = 4.4 \pm 0.4$
2-3	65	$\bar{x} \pm 2 \text{ SD} = 4.2 \pm 0.4$
3-4	49	$\bar{x} \pm 2 \text{ SD} = 4.0 \pm 0.4$
4-5	51	$\bar{x} \pm 2 \text{ SD} = 4.0 \pm 0.4$
5-6	43	$\bar{x} \pm 2 \text{ SD} = 4.0 \pm 0.4$
6-7	44	$\bar{x} \pm 2 \text{ SD} = 3.9 \pm 0.4$
7-8	42	$\bar{x} \pm 2 \text{ SD} = 3.8 \pm 0.4$
8-9	25	$\bar{x} \pm 2 \text{ SD} = 3.7 \pm 0.4$
9-10	20	$\bar{x} \pm 2 \text{ SD} = 3.7 \pm 0.4$
10-11	22	$\bar{x} \pm 2 \text{ SD} = 3.7 \pm 0.4$
11-12	24	$\bar{x} \pm 2 \text{ SD} = 3.6 \pm 0.4$
12-13	26	$\bar{x} \pm 2 \text{ SD} = 3.5 \pm 0.2$
13-14	25	$\bar{x} \pm 2 \text{ SD} = 3.4 \pm 0.2$

Fig. 2 Renal-vertebral index plotted against age in years.

Results

The roentgenograms of the 822 normal children were divided into groups from birth to 6 months, from 6 months to 1 year, and then yearly to 14 years (Table).

The number of children in each age group and their corresponding mean value ± 2 standard deviations of their R-V indices are tabulated. Roughly, for everyday clinical practice, it can be said that R-V index of infants under 1 year is about 4 to 5, in preschool children (1-5 years) it is $3\frac{1}{2}$ to $4\frac{1}{2}$, and in school-children (5-14 years) $3\frac{1}{2}$ to 4. Fig. 2 shows this graphically; its linear curve declines gradually and smoothly.

Renal length estimated in boys and girls separately did not show significant difference. There was also no significant difference between right and left kidney size in this series of children.

Discussion

The study was designed to provide a simple standardised method for evaluating renal length of

children, convenient for everyday clinical practice, by calculating the R-V index of normal children.

The upper border of the 12th thoracic body was chosen as a constant starting point for measurement of the number of vertebral bodies corresponding to the renal length, because in that site are usually found the upper poles of the kidneys which can be easily traced in radiographs. From the data presented it is apparent that R-V index reduces as the child grows.

In infants it ranges approximately from 4 to 5, in preschool children from 3.5 to 4.5, and in older children it is about 3.5 to 4.

Correlation of renal length with the number of vertebral bodies was studied by Simon.⁵ He compared kidney length of adults with height of the second lumbar vertebra. Currarino⁶ correlated kidney length with vertebral body height in children. He found that children older than $1\frac{1}{2}$ years had an average kidney length corresponding to the first 4 lumbar vertebral bodies including their 3 intervertebral spaces; he noticed that the normal kidney length during the first $1\frac{1}{2}$ years of life was greater. Eklöf and Ringertz⁷ also correlated kidney length to the length of the lumbar segment L1 to L3 including the intervertebral spaces, and produced a standard normogram.

Our results agree with those of Gatewood *et al.*⁸ only for the newborn infants. At other ages the difference may be because they investigated a smaller number of children (total 130) and their starting point of calculation of vertebral bodies was variable.

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Correspondence to Dr C Bacopoulos, Aghia Sophia Children's Hospital, Athens 617, Greece.

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