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Measurement of renal size in preterm and term infants by real-time ultrasound

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SUMMARY The kidneys in term and preterm infants were visualised by real-time ultrasound scanning. A cross-sectional centile chart has been plotted for kidney length in 100 unselected infants ranging in gestational age from 26 to 42 weeks. The ratio of kidney length to crown-to-heel length appeared to remain constant despite abnormalities in intra-uterine growth rate.

Evaluation of the fetal kidneys by ultrasound has been reported.¹ By 15 to 17 postmenstrual weeks half of fetal kidneys can be visualised on ultrasound examination and by 20 postmenstrual weeks 95% of fetal kidneys can,² thus allowing abnormalities in growth or structure to be diagnosed prenatally. In the newborn period abdominal ultrasound is being increasingly used as a diagnostic tool, the main indications being palpable masses, suspicion of obstructive uropathy, and the presence of congenital abnormalities. Descriptions of the ultrasound diagnosis of renal vein thrombosis and adrenal haemorrhage in the neonate have been reported.^{3,4} Despite the variety of renal disease recognised by ultrasound there are no data on normal renal size and architecture in the preterm or term infant, probably because of the lack of good resolution portable high frequency real-time equipment. We report here a study of kidney growth in preterm and term infants.

Subjects and methods

An ATL real-time mechanical sector scanner was used to visualise the kidneys. Scanning was performed with a 7.5 MHz transducer with the child lying either supine or prone. In the supine

position the liver could be used as an acoustic window to visualise the right kidney (Fig. 1) and the left kidney was approached from the flank, by scanning through the spleen. In the prone position

Fig. 1 Longitudinal scan of right kidney (upper) and cross-sectional scan at the level of the renal pelvis (lower) using a 7.5 MHz mechanical sector scanner. Arrows indicate the points at which measurements are made.

the kidneys were scanned with the transducer parallel to the vertebral column. In preterm infants the supine position was most often used, while in term ones the prone position was preferred. Several sections of the kidneys were made in the longitudinal plane to determine the maximum length of each kidney. Two measurements were made at each examination and averaged. The electronic calipers were calibrated before each examination session.

One hundred unselected infants ranging from 26 to 42 weeks' gestation were studied. Twenty-five were normal term infants examined on the postnatal ward after informed parental consent had been obtained. The remaining 75 infants had been admitted to a neonatal unit for observation or treatment. The first scan was performed within the first 3 days of life, 82% of them within 48 hours. The crown-to-heel length was measured in some infants.

Results

Fig. 2 shows the distribution of kidney length by gestational age in 95 infants (5 were excluded because of renal abnormalities). In view of the small numbers of infants in certain gestational age groups, some measurements were grouped together for the purpose of analysis. The mean and standard deviation was calculated using Healy's method⁵ for each gestational age group. Fig. 3 shows a cross-sectional centile chart of kidney length with the smoothed 3rd, 50th, and 97th centiles for gestational ages 26 to 42 weeks. In 10 infants measurements of kidney size were made three times during the course of an hour and the size did not vary by more than 2 mm. In 6 infants the left kidney could be visualised only partially, and accurate measurements were not possible. The ratio of kidney length to crown-to-heel

Fig. 2 Distribution of kidney length by postmenstrual age. Means (± 2 SD) have been calculated for groups: 26–28, 29–30, 31–32, 33–34, 35–36, 37–39, 40–42 postmenstrual weeks (horizontal lines).

Fig. 3 Smoothed cross-sectional growth charts showing the mean (± 2 SD) for postmenstrual ages 26–42 weeks.

measurement was made in 20 infants. The ratio ranged from 0.70 to 0.85 with a mean of 0.78. In infants who were either small or large for gestational age the kidney size remained in proportion with the length of the infant. There was no statistically significant difference in the length between the right and left kidneys. In general the newborn kidney image appeared to be similar or of slightly lower reflectivity than the liver.

Discussion

Although data on intrauterine kidney growth rates are available in a few fetuses² this is the first report of kidney growth in the preterm infant. With the increased use of real-time ultrasound in the neonatal unit this information is clearly important in order to diagnose deviant kidney size. Although the technique is simple, some experience is necessary before repeatable measurements are obtained. The best visualisation of the kidneys is obtained during the first few days of life before the child is established on gastric feeds. Once the bowel becomes full of gas total reflection of sound from the gas or tissue interface occurs, making precise measurement of the kidneys more difficult. This was so for the left kidney and in 6 infants measurement on the left could not be made. In addition, in a few preterm infants it was difficult to visualise both poles of the left kidney simultaneously on the screen. In each the infants' small size and the presence of thin subcutaneous tissues prevented sufficient distance to be obtained between the kidney and the transducer. A stand-off water bag was tried in an attempt to overcome this problem but met with only limited success.

Neonatal kidneys can be clearly visualised with real-time ultrasound using a 7.5 MHz mechanical sector transducer. The portability of the equipment allows rapid scanning of most infants—including those on

mechanical ventilators or those undergoing other forms of intensive care—and with little handling or disturbance. The value of this technique lies in its ability to measure non-invasively kidney size and to detect structural abnormalities. Further studies will establish the frequency of such abnormalities and allow study of the natural history of such conditions.

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Neonatal pericardial effusion associated with central eventration of the diaphragm

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SUMMARY A normal infant born at term developed tachypnoea. A massive pericardial effusion associated with absent central tendon of the diaphragm and eventration into the pericardium was found. Surgical correction was performed and the baby is now well and developing normally.

Case report

A 3.8-kg boy, the second son of healthy unrelated white parents, was born by caesarean section after induction of labour failed at 41 weeks' gestation. He required no resuscitation and general examination was normal. His 29-year-old mother had clinical signs of polyhydramnios from 32 weeks' gestation, which was confirmed by ultrasound scan but no fetal abnormality was seen. After birth the infant was apparently well until 21 hours of age when tachypnoea at rest was noticed. The respiratory rate was 80–90 per minute with subcostal recession and nasal flaring; crepitations were heard at the bases of both lungs, but air entry and chest expansion were normal. Peripheral perfusion was good, and all the pulses were present and of normal volume. Systolic blood pressure was 60 mmHg in both the arms and legs. The heart sounds were soft and there were no murmurs or pericardial rub. The liver was palpable 3 cm below the costal margin but there was no peripheral oedema.

Radiographs of the chest showed a greatly enlarged cardiac shadow (Fig. 1). The electrocardiogram was of normal voltage with an axis of $+120^\circ$ and without evidence of ventricular enlargement. The PaO_2 rose to 210 mmHg in 50% inspired

Fig. 1 Chest radiograph showing large cardiac shadow and evidence of pulmonary venous congestion.