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CLINICAL STUDY

Abnormal kidney ultrasound and function in a five-year-old boy born prematurely with a birth weight of 370 grams

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ABSTRACT
It is known that prematurity and low birth weight are associated with chronic kidney disease and hypertension. A positive correlation between kidney volume and birth weight was also described. In our ongoing observational study we revealed highly abnormal kidney ultrasound and renal functions in a male patient (birth weight 370 grams) at the age of five. It was his first nephrology examination since discharge from the hospital. We believe that thorough follow up and timely diagnosis of developing renal insufficiency may help us to initiate proper treatment in high-risk children *(Tab. 1, Fig. 1, Ref. 7)*. Text in PDF *www.elis.sk*
KEY WORDS: prematurity; extremely low birth weight; chronic kidney disease; renal ultrasound; renal function.

Case Report

An extremely preterm boy with a birth weight of 370 grams was born by caesarean section at 25 2/7 weeks of gestation due to early onset preeclampsia. Complete induction of foetal lung prematurity was completed with corticosteroids (CS). After birth, the infant suffered from severe respiratory distress syndrome requiring intubation, surfactant, and mechanical ventilation. The umbilical lines were placed and short-term inotropic support was administered. On the 17th day of life, the boy developed septic shock with an acute kidney injury (AKI) caused by *Staphylococcus aureus*. Subsequently, severe bullous bronchopulmonary dysplasia with tension pneumothorax developed and the infant required prolonged ventilation support (including high frequency oscillatory and jet ventilation). Extubation attempts were initially unsuccessful despite repeated courses of systemic CS to improve lung function. Finally, successful extubation was performed during the 4th month of life. Other neonatal morbidities included grade 1 intraventricular haemorrhage, grade 2 retinopathy of prematurity, and persistent ductus arteriosus – all with spontaneous regression. In total, the boy spent 6 months in the hospital and was discharged with a weight of 2780 g and on home oxygen treatment that was terminated at the age of 2.5 years.

Before his 6th birthday, the boy was examined in our observationel case control study focused on renal functions in children. His growth, nutrition, and body composition were analysed by an anthropologist. Anthropometry revealed the presence of significant catch-up growth in the first years of postnatal development and progressive short stature after the 3rd year of life. Underweight, mainly affecting muscles, was evident throughout the period. Disproportion of trunk and limbs was not demonstrated. However, nonhereditary microcephaly combined with postural ultrabrachycephaly and plagiocephaly was detected. Blood and urine samples were analysed and kidney ultrasound (US), together with ambulatory blood pressure monitoring (ABPM), were performed. The boy had decreased kidney function, mild proteinuria, and elevated LDL cholesterol (Tab. 1), and had no haematuria or signs of tubulopathy (there were no metabolic acidosis, electrolytes abnormalities, or urine abnormalities suggesting tubulopathy like glucosuria or decreased specific urine gravity). The US showed hyperechogenic kidneys with abnormal corticomedullary differentiation and the kidney length was below the 2.5th percentile

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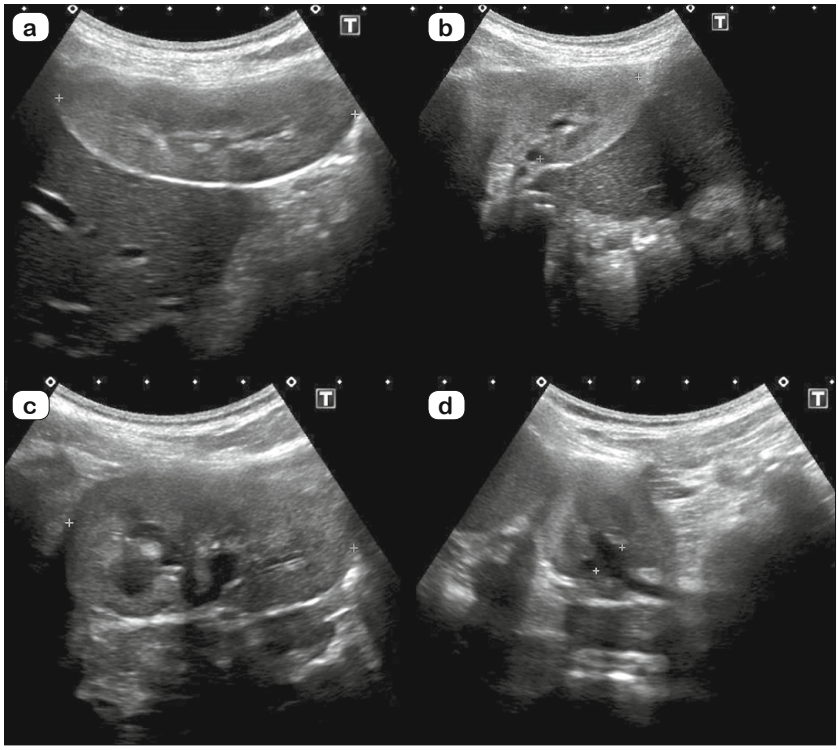

Fig. 1. Renal ultrasound. Right kidney (length 61 mm) with altered corticomedullary differentiation – longitudinal view (a). Right kidney – anteroposterior view (b). Left kidney (length 60 mm) with altered corticomedullary differentiation – longitudinal view (c). Left kidney (pelvis width 7.2 mm) –anteroposterior view (d).

(Fig. 1). ABPM showed day-time diastolic hypertension (HTN), though night-time blood pressure was normal (Tab. 1). The boy had neither history of urinary tract infection nor administration of nephrotoxic medication after discharge from neonatology, and this was his first nephrologist check-up. The mother was not educated by any specialist about the association between low birth weight (LBW), AKI, chronic kidney disease (CKD), and HTN, thus we recommended continuing with the nephrology follow-up.

Discussion

There is a strong correlation between prematurity, birth weight, and total number of nephrons, as nearly 60 % of nephrons are developed in the third trimester of pregnancy (1, 2). Normally, nephrogenesis does not occur after birth. In preterm newborns, nephrogenesis may continue 40 days after birth; however, it can be insufficient and altered with the development of abnormal glomeruli (3). This process may be further damaged by insults like AKI, which is very common in preterm infants (3, 4). Many glomeruli in the outer cortex of the preterm kidney can be morphologically and functionally abnormal (enlarged Bowman's capsule, shrunken glomerular tuft) (4). The reduction of functional glomeruli can cause glomerulomegaly (compensatory mechanism through hyperfiltration), which may be responsible for maintaining normal creatinine levels (1, 2). As a consequence, LBW status is associated with an increased risk of HTN, proteinuria, and progressive CKD at later age (1, 2).

We report hyperechogenic renal parenchyma and altered corticomedullary differentiation found on kidney US in a 5-year-old premature child. Hyperechogenicity is a nonspecific sign that may be found in many kidney diseases like glomerulopathies, renal dysplasia, or polycystic kidney disease; however, it was not described in previous studies in relation with premature children (5). The kidneys were also significantly smaller than predicted length by age and actual height (6). Decreased kidney function and proteinuria were also found, as well as elevated LDL cholesterol (but there was a history of hyperlipidaemia in the maternal family) and day-time diastolic HTN (the validity of ABPM could have been further improved by increasing the number of mesurements). We suppose that abnormal US, decreased renal function, and mild proteinuria in our patient is a consequence of extreme LBW in combination with AKI and nephrotoxic medication at early age. This statement may be supported by previous studies and we found no other explanation for the results (1). Previous authors found a high proportion of causative mutation in consanguineous or familial cases with childhood-onset increased renal echogenicity, but in our case, the parents were not consanguineous and there was no history of any kidney disease in the family. The kidneys of the boy were not dysplastic, there were no cysts, and laboratory results did not suggest nephronophthisis, tubulopathy, or hereditary glomerulopathy (7).

In our opinion, the boy should have been recommended for nephrology follow-up when being discharged home from the neonatology department and the parents should have been informed about the possible risk of developing CKD and HTN. Our case demonstrates that the problem of association between LBW, CKD, and HTN is either not well known to physicians or is not given much importance. Further investigation will determine which subgroup of LBW children should start their follow-up earlier. Nevertheless, we propose that LBW newborns should be considered as being at high risk for early CKD and HTN, like our patient, who was born with a very low number of nephrons that were probably further damaged after birth.

Learning points

- Abnormal kidney ultrasound and altered kidney functions may be found at early age in children born with extremely low birth weight.

- The association between low birth weight and chronic kidney disease has been established, yet it seems that clinicians either do not know about the association or do not give the topic sufficient importance.
- Thorough follow up and timely diagnosis of developing renal insufficiency may help us to initiate proper treatment in high-risk children.

Tab. 1. Results of laboratory, blood pressure, kidney ultrasound, and anthropology studies.

Laboratory study	Value (unit)
S-creatinine	41 (μmol/L)
S-cystatin C	1.19 (mg/L)
S-urea	6.3 (mmol/L)
GFR (Creatinine-Cystatin C-based CKID equation)	71.3 (mL/min/1.73m^2)
GFR (Cystatin C based equation)	60.1 (mL/min/1.73m^2)
S-uric acid	216 (μmol/L)
S-Total cholesterol	6.4 (mmol/L)
S-HDL cholesterol	1.43 (mmol/L)
S-LDL cholesterol	4.56 (mmol/L)
U-P/creatinine	26 (mg/mmol)
ABPM	Value (unit)
Systolic day-time BP	107 (torr)
Diastolic day-time BP	84 (torr)
Percent of day-time sBP/dBP > 95th percentile	0/100 (%)
Systolic nocturnal BP	82 (torr)
Diastolic nocturnal BP	53 (torr)
Percent of nocturnal sBP/dBP > 95th percentile	0/6.7 (%)
Number of daily measurements	3
Number of nocturnal measurements	15

Anthropology study (unit)	Value (SD)
Height (cm)	100.7 (–3.7)
Weight (kg)	13 (–4.6)
BMI (kg/m^2)	12.8 (–2.1)
Index of sitting height and body height (I.U.)	53.9 (–0.5)
Abdominal circumference (cm)	45.5 (–2.9)
Arm circumference	15.8 (–1.5)
Calf circumference	18.2 (–3.0)
Head circumference (cm)	44.1 (–5.2)
Index cephalicus (I.U.)	96.3
Mother‘s height (cm)	153.5
Father‘s height (cm)	174.0
Midparent height (cm)	170.3
BSA (m^2)	0.6
Growth rate in the 1st year (cm/year)	33.3 (+4.4)
Kidney Ultrasound	Value (unit)
Right kidney – length	61 (mm)
Right kidney – volume	21899 (mm^3)
Right kidney – relative volume (volume/BSA)	36499 (mm^3/m^2)
Left kidney – length	60 (mm)
Left kidney – volume	24570 (mm^3)
Left kidney – relative volume (volume/BSA)	40950 (mm^3/m^2)

ABPM – ambulatory blood pressure monitoring, BMI – body mass index, dBP – diastolic blood pressure, GFR – glomerular filtration rate, HDL – high-density lipoprotein, LDL – low-density lipoprotein, P – protein, S – serum, sBP – systolic blood pressure, SD – standard deviation, U – urine, BSA – body surface area

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