The impact of fetal renal pelvic diameter on postnatal outcome

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INTRODUCTION

Fetal pyelectasis is the most common prenatal diagnosed malformation with 0.2 to 1% of all pregnancies (Thomas, 1990). Fetal renal pelvic dilatation is commonly observed during prenatal ultrasound examination, but its clinical significance remains unclear. The number of otherwise healthy fetuses that are diagnosed with this condition is on the increase, with the growing use of ultrasound in obstetrics. As a result, more infants with this history are being presented to pediatricians, nephrologists and urologists. The most common urinary tract abnormality is a nonspecific hydronephrosis. Almost half of all prenatally diagnosed hydronephroses that are found after investigation are an isolated upper-tract dilatation. This population has posed the greatest challenge in prospectively determining which of these asymptomatic children have an obstruction that would benefit from surgery, as opposed to a simple dilatation that may be inconsequential to their well-being (Dhillon, 1998). Various cut-off values for dilatation of the fetal renal pelvis are being described as requiring postnatal investigation (Anderson et al., 1995; Corteville et al., 1991; Fasolato et al., 1998; Mouriquand et al., 1999; Kent et al., 2000, Siemens et al., 1998). The outcome and proper management of fetal hydronephrosis are not defined sufficiently. The prognosis of obstructive urinary tract anomalies is variable and depends on several conditions: the gestational age at diagnosis, the localization of the stenosis, the bilateral or unilateral alteration of the kidneys, and the amount of amniotic fluid as an indicator for renal function. Spontaneous resolution has been described as well as the progression into a severe obstruction with development of cystic renal dysplasia and the loss of renal function (Sohn and Tercanli, 2003). In general terms, the pediatrician’s goal concerning newborns diagnosed with pyelectasis or hydronephrosis should be to strike the right balance between excessive medical intervention (long, costly and often useless follow-ups, which arouse unjustified and/or disproportional parental anxiety) and sufficient intervention to diagnose potentially dangerous conditions (Fanos et al., 2000).

This study was performed in order to assess the clinical impact of prenatal ultrasonographically detected fetal renal pelvic dilatation and to determine thresholds for the fetal renal anterior–posterior diameter (APD) predicting postnatal clinically relevant pelvicaliceal dilatations.
PATIENTS AND METHODS

One hundred and ninety-six pregnant women were referred to our university hospital (from January 1990 to December 1999) because of a suspected renal anomaly, identified during a prior external ultrasonographic examination. They were to be examined using the especially fine diagnostics permitted by ultrasonography utilizing a 3.75 MHz transducer (Toshiba SSA 270 A). All 196 infants had postnatal nephro-urological examination. One hundred and forty-eight patients were included in this study with: (1) prenatal isolated unilateral or bilateral renal pelvic dilatation defined as follows: <33 weeks of gestation anterior–posterior diameter (APD) ≥4 mm and ≥33 weeks of gestation APD ≥7 mm; (2) postnatal ultrasound diagnosis for each kidney according to the Society for Fetal Urology grading system (Fernbach et al., 1993) at the age of three months: (a) normal (NORMAL): without any pelvic dilatation, (b) pyelectasis (PYECT): without caliceal dilatation or when a few but not all calices are identified, (c) pelvicaliceal dilatation (PCD), (d) dilated ureter and pelvicaliceal dilatation (UPCD).

In our management, micturating cystourethrogram (MCUG) is not recommended for all infants with prenatal pelvic dilatation. We performed MCUG only in those 55 of 152 infants with postnatal PCD or UPCD. We found bilateral refluxes in four infants (two boys, two girls; grade 3 in three kidneys, grade 4 in four and grade 5 in one kidney). Since this diagnosis may only be made by virtue of the postnatal MCUG, which was not performed in all patients of our study, these four cases were excluded for further analysis.

Forty-four of one hundred and ninety-six patients with gross structural anomalies of the urinary tract were excluded prior to entry of study analysis: duplication (n = 11), multicystic dysplastic kidney (n = 16), posterior urethral valves (n = 3), and miscellaneous (n = 14).

A total of 433 prenatal and 502 postnatal ultrasound investigations in 148 patients were performed at an average of 6.3 scans per patient. All 148 patients with 296 renal units had at least one ultrasound examination before and/or after 33 weeks of gestation. Measurement of the APD only before 33 weeks of gestation was performed in 35, only after 33 weeks of gestation in 51, and in both time periods in 62 patients. In our retrospective study, we did not evaluate the reasons for no further renal scan in pregnancy for the 35 subjects who had only one renal scan. Finally, 194 kidneys were examined before 33 weeks’ gestation and 226 kidneys ≥33 weeks’ gestation, respectively. Prenatal ultrasound was done at a median (min; max) fetal patient age of 23 weeks of gestation (min 18; max 32) in the group <33 weeks of gestation and 37 weeks (min 33; max 41) in the group of over 33 weeks of gestation. After birth, all 148 infants were followed-up, performing at least one ultrasound examination until three months of life using a 5 to 7 MHz transducer (Acuson 128 XP-10). Median follow-up time was 1.14 years (min 0.01; max 9.1) in postnatal life.

In all infants with PCD or UPCD, at least one 99m-TcMAG 3 diuresis renography with furosemide washout was performed to evaluate function and drainage. An obstructive washout pattern was defined as the half-time radiotracer washout longer than 20 min (O’Reilly et al., 1996).

An indication for surgery was given: (1) if the hydronephrotic kidney showed decreased differential function (<40%) and an obstructive type of the washout curve in diuresis renography; (2) in cases with normal differential function but an obstructive type of drainage curve at least in two investigations in combination with an unchanged or increased pelvicaliceal dilatation.

Statistical analysis

Multiple thresholds were analyzed for the fetal renal pelvic APD and correlated with infant outcome. The goal was to choose the threshold with the highest sensitivity for predicting congenital pelvicaliceal dilatation. The receiver-operating characteristic (ROC) plots of various fetal APD thresholds were created from sensitivity versus 1-specificity calculated from cross-tables to discriminate between kidneys with and without a subsequent postnatal relevant pelvicaliceal dilatation (kidneys with PCD or UPCD). The Kruskall–Wallis test was used to confirm differences between the various groups of diagnosis followed by comparison in pairs (Mann Whitney U-test). Differences were considered to be statistically significant at a P-value <0.05.

RESULTS

From 148 infants, a fetal pelvic dilatation was diagnosed, which was bilateral in 72 and unilateral in 76 fetuses. Postnatally, we found bilateral NORMAL kidneys in 38 infants. Sixty-eight infants had unilateral involvement with the diagnoses PYECT, PCD, UPCD, and 42 bilateral combined with corresponding diagnoses. Finally, for further analysis of renal APD, we considered all 296 kidneys (148 patients) including postnatal diagnoses: NORMAL: n = 144; PYECT: n = 98; PCD: n = 33 and UPCD: n = 21.

APD in prenatal ultrasound scans

The median (range) APDs of the prenatal scans below 33 weeks of gestational age found in the various groups NORMAL, PYECT, PCD and UPCD were 5.0 mm (1.0–9.0), 6.6 mm (3.5–16.0), 10.8 mm (6.0–28.8) and 7.1 mm (4.0–13.0), respectively. The corresponding values of APDs ≥33 weeks of gestational age were 5.0 mm (2.0–15.0), 9.0 mm (2.3–18.0), 18.0 mm (7.1–36.0) and 13.8 mm (8.0–32.0), respectively.

At 18 to 32 weeks’ gestation, significant differences of the fetal renal pelvic APD of NORMAL kidneys versus PYECT, PCD and UPCD were found by comparison in pairs (p < 0.001), although the APDs of kidneys with UPCD compared with PCD or PYECT did not
not show significant differences \( (p = 0.054, p = 0.240) \), respectively.

At the time period 33 to 41 weeks’ gestation, the fetal renal pelvic APDs differed significantly for the various kidney diagnoses: NORMAL, PYECT, PCD and UPCD \( (p < 0.0001) \). However, no significant difference of the renal APD between PCD and UPCD \( (p = 0.242) \) was found (Figure 1). Of 62 infants who did have more than one scan before and after 33 weeks, eight had an APD below 7 mm in both kidneys at the post-33-week scan. Moreover, they had no renal dilatation in the scan after birth.

ROC analysis predicting subsequent postnatal pelvicaliceal dilatation

Using a threshold of 7 mm, it was found that fetal renal pelvic dilatation was 89.3% sensitive and 78.9% specific at <33 weeks (Figure 2a). The best correspondence between sensitivity and specificity ≥33 weeks showed the threshold of 10-mm renal pelvic dilatation with 88.4% and 78.6% in predicting subsequent pelvicaliceal dilatation, respectively (Figure 2b). This was accomplished by using a receiver-operating characteristic curve categorizing the prenatal sonograms into gestational periods and varying the threshold of APD in each period. Using a threshold of 4 mm (<33 weeks) and 7 mm (≥33 weeks) yielded a sensitivity of 100% and a specificity of 18.7 and 47.8%, respectively (Figure 2a,b).

APD in surgically and conservatively treated patients

All infants with only uni- or bilateral NORMAL and PYECT \( (n = 97) \) were treated conservatively. Seventeen of thirty-three kidneys with PCD and 8 of 21 kidneys with UPCD required unilateral surgical treatment. Altogether, 25 of 148 children (17%) had surgical treatment. In order to test the differences of the renal pelvic APD at various gestational periods between surgically and conservatively treated children, only the children with postnatal diagnosed pelvicaliceal dilatation (PCD and UPCD) were analyzed.

At <33 weeks’ gestation, the median APDs (range) <33 weeks’ gestation of conservatively treated patients \( (n = 17) \) and surgically treated patients \( (n = 17) \) were 10.3 mm (4–19) and 11.0 mm (7–23), respectively \( (p = 0.683) \).

At 33 to 41 weeks’ gestation, the median APDs (range) in conservatively treated \( (n = 16) \) and in patients requiring surgery \( (n = 23) \) were 13.3 mm (7–21) and 19.0 mm (9–36), respectively \( (p = 0.001) \) (Figure 3).

Thirteen of fourteen patients who had an APD ≥19 mm at the 33 to 40 weeks’ gestational period underwent surgical intervention postnatally.

DISCUSSION

Prenatal ultrasonography has identified a large population of fetuses with a urinary tract abnormality that is most commonly a nonspecific upper-tract dilatation with or without ureteric dilatation. Ultrasonographic
identification *in utero* of fetuses at risk of subsequent pelvicaliceal dilatation can minimize diagnostic delays and potentially reduce morbidity (Ouzounian *et al.*, 1996). Our approach was to predict such fetuses that will suffer from significant renal pathology to be identified prior to clinical presentation.

The fetal renal APD was analyzed before and after 33 weeks of gestation. The APD of the fetuses with subsequent neonatal PCD was different from those with no dilatation or pyelectasis at any gestational period. Whereas the fetal renal APD of fetuses with future neonatal PYECT and UPCD did not differ in the early period below 33 weeks of gestational age, the distinction after this time was significant (Figure 1). The fetal renal APD showed no difference between PCD and UPCD at any prenatal period. Therefore, the crucial role of the ureter distinguishing PCD from UPCD will be clear at any prenatal period. Therefore, the crucial role of the ureter distinguishing PCD from UPCD will be clear at any prenatal period. Consequently, postnatal surgery was required. The speciﬁcity of our study was highly signiﬁcant (28 of 33 weeks' gestation). After this time, however, the difference was highly signiﬁcant. Our study shows that fetuses with APD $\geq 7$ mm after 33 weeks' gestation will have a significant risk of postnatal surgery. The study

10 mm $\geq 33$ weeks' gestation yielded the highest combined sensitivity and specificity (89 and 78%, respectively) for predicting a subsequent pyelocalyceal dilatation. In order to identify all ‘at risk’ fetuses, a lower fetal renal APD of $\geq 4$ mm before 33 weeks and $\geq 7$ mm $\geq 33$ weeks would be required. The specificity, however, associated with these thresholds would be 18.7 and 47.8%, respectively. An APD of $\geq 4$ mm at the first trimester is the most commonly used cut-off to denote hydronephrosis (Stocks *et al.*, 1996; Sairam *et al.*, 2001; Adra *et al.*, 1997; Kitagawa *et al.*, 1998). A recent study revealed that the third trimester anterior–posterior renal pelvis diameter of $\geq 7$ mm was the best ultrasound criterion to predict postnatal uropathies (Ismaili *et al.*, 2003). Ouzounian *et al.* (1996) have demonstrated that fetal pyelectasis of 8 mm produced the best combination of sensitivity and specificity, 91 and 72% respectively. In order to achieve 100% sensitivity, they recommend postnatal renal ultrasonography for patients with fetal pyelectasis of $\geq 5$ mm at any gestational age. Mandell *et al.* (1991) found that the degree of dilatation did not correlate well with postnatal findings. They therefore recommended clinically significant thresholds for pyelectasis of 5 mm between 15 and 20 weeks, 8 mm between 20 and 30 weeks and $\geq 10$ mm after 30 weeks. By using a cut-off value of 10 mm as recommended by other authors (Sairam *et al.*, 2001), 11% of the neonates of our study would not have been recognized. The false-positive rate declines with advancing gestational age. A critical note to these high demands for security is the fact that they may lead to unwarranted parental concern as well as expensive postnatal diagnostic studies. In 8 of 62 infants (13%), the fetal renal APD had resolved $< 7$ mm at the post-33-week scan and showed no dilatation postnatally. Our findings support the results of Kent *et al.* (2000) that the fetus with a normal repeat ultrasound at 28 to 34 weeks would not require a postnatal scan.

For our application, the important practical criterion in prenatal ultrasonography to distinguish future abnormal postnatal ultrasound scans for the diagnostics of PCD and UPCD include pelvic, caliceal and/or ureteral dilatation and changing dilatation during the examination. Measurement of the fetal renal APD has emerged as a sensitive and accurate technique for the 100% identification of children with possible fetal renal abnormalities.

Surgical rates from 7 to 40% in children with pre-natal hydronephrosis have been described (Gunn *et al.*, 1995; Corteville *et al.*, 1991). The largest prospective study of Sairam *et al.* (2001) in an unselected routine obstetric population of 11,465 children revealed 11 of 75 fetuses (15%) with hydronephrosis who underwent postnatal surgery. In our study, 25 of 148 children (17%) underwent postnatal surgery. All of them had PCD or UPCD. None of the children with simple pelvic dilatation required surgery. The fetal renal APD of post-natally surgically treated patients compared with conservatively followed-up patients showed no difference below 33 weeks' gestation. After this time, however, the difference was highly significant. Our study shows that fetuses with APD $\geq 19$ mm after 33 weeks' gestation have a significant risk of postnatal surgery. The study

Figure 3—Median fetal renal pelvic APD (mm) in patients $< 33$ and $\geq 33$ weeks' gestation with surgery versus conservative therapy in postnatal life.
group of Gotoh et al. (1998) found in their population, 6/36 fetuses requiring neonatal surgery. The mean anterior–posterior diameter in those who did not require surgery at infancy (11 ± 6 mm) was significantly less than those requiring surgery (30 ± 14 mm, p < 0.01). In accordance with our results, Gotoh et al. (1998) recommended surgery if diameters at 30 to 40 weeks’ gestation are at least 20 mm.

The discussions continue about imaging modalities and indication for surgery to be modified and improved in the hope of identifying a parameter that could prospectively identify those infants whose hydronephrosis does represent an obstruction that could be detrimental to their well-being.

**CONCLUSION**

In addition to providing guidelines for diagnosis of fetal renal pelvic dilatation, this study also gives valuable information for the counsel of future parents. We recommend that ultrasonographically detected prenatal fetal renal pelvic dilatation of ≥4 mm before 33 weeks and ≥7 mm from 33 weeks of gestation should entail a postnatal follow-up ultrasound examination. In cases of fetal renal pelvic dilatation before 33 weeks’ gestation, a repeated ultrasound scan after 33 weeks’ gestation is mandatory in order to detect dynamic and possible progress. A detailed postnatal evaluation including a voiding cystourethrography and a renal nuclear scan is required if pelvicaliceal dilatation and/or ureter is confirmed in neonates. Fetuses with a pelvic dilatation of more than 19-mm APD have a significant chance of requiring surgery. The dilatation of an APD >4 mm before 33 weeks, which had resolved at the post-33-week scan needs no further investigation in the postnatal period.

**REFERENCES**


