



Time to resolution of isolated antenatal hydronephrosis with anteroposterior diameter ≤ 20 mm

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Received: 29 November 2018 / Revised: 28 February 2019 / Accepted: 1 March 2019 / Published online: 19 March 2019
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Abstract

Data regarding spontaneous resolution of mild hydronephrosis consist of different etiologies, and hence, it is heterogeneous. The aim of this study is to evaluate spontaneous resolution rates and the time to complete resolution of antenatally detected isolated hydronephrosis in patients with renal pelvis antero-posterior diameter (RPAPD) ≤ 20 mm. Retrospective chart review of patients who were admitted to our pediatric nephrology clinic for the evaluation of antenatal hydronephrosis between 2011 and 2017 was conducted. Patients that had hydronephrosis with RPAPD ≤ 20 mm, < SFU (Society for Fetal Urology) grade IV on initial postnatal evaluation, and ≥ 3 months of follow-up with at least two renal ultrasounds (US) were included. Complete resolution of hydronephrosis was regarded as SFU grade 0 with a RPAPD of < 7 mm. Patients with ureteric and lower urinary tract abnormalities were excluded. There were a total of 276 patients who met the inclusion criteria. Median follow-up was 16 months (range 3–96 months). Hydronephrosis completely resolved in 198 patients (71.7%). Surgery was not required in any of the patients; however, nine patients (3.3%) showed progression to higher grades of hydronephrosis or increase in AP diameter. Median time to complete resolution of hydronephrosis was 6 months (range 2–35 months) in our study. Those with AP diameter < 10 mm became normal in median of 5 months, while it took median 11 months for patients with AP diameter 10–20 mm to become normalized ($p < 0.001$).

Conclusion: Isolated antenatal hydronephrosis with RPAPD ≤ 20 mm would spontaneously resolve in 71.7% of the cases. Resolution may be expected to happen in 3 years, while the majority will take place in the first year of life.

What is Known:

- Antenatal hydronephrosis comprises an important amount of clinical visits.
- Spontaneous resolution rates differ for various etiologies.

What is New:

- Isolated antenatal hydronephrosis with RPAPD ≤ 20 mm completely resolves within 3 years in approximately 72% of the cases.
- Resolution can be observed within the first year of life in most of the cases.

Keywords Antenatal hydronephrosis · Spontaneous resolution · Follow-up

Communicated by Mario Bianchetti

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Introduction

Antenatal hydronephrosis can be observed in 1–2% of all pregnancies. However, a fair amount of these regress and only 10–40% may end up with diagnosis of a urological anomaly [12, 16]. The main concern is to differentiate between hydronephrosis that would resolve spontaneously from that would cause renal functional loss and thus, require surgery. In this context, information on resolution of various degrees of hydronephrosis is important. On the other hand, there are reports that surgical intervention may be required for even mild or moderate degrees of hydronephrosis [9].

Studies on the resolution of antenatally detected hydronephrosis are generally heterogeneous that include all

etiologies such as ureteropelvic junction obstruction (UPJO), vesicoureteral reflux (VUR), posterior urethral valves (PUV), and primary megaureter [12]. The wide range of spontaneous resolution rates in these studies (57–98%) indicates that resolution is highly dependent on the primary pathology [13].

Although patients with isolated mild-moderate hydronephrosis comprise a huge amount of patients admitted in clinics, data on time to complete spontaneous resolution and ideal follow-up schedule is scarce [6, 10, 15]. The aim of this study is to evaluate spontaneous resolution rates and assess the time to complete resolution of antenatally detected isolated hydronephrosis without ureteral dilation (UPJO like hydronephrosis) in patients with renal pelvis antero-posterior diameter (RPAPD) ≤ 20 mm.

Materials and methods

After obtaining local board approval, a retrospective chart review of patients who were diagnosed with antenatal hydronephrosis [11] between 2011 and 2017 in a single women's maternity and children's hospital was conducted. Assessments of ultrasonography (US) images were made as per Society for Fetal Urology (SFU) grading system and RPAPD [8, 11]. In addition to antenatal detection of hydronephrosis, inclusion criteria were as follows: (i) RPAPD ≤ 20 mm in first postnatal renal US and (ii) minimum 3 months of follow-up and at least two renal US. Those with insufficient data were excluded. Also, patients with ureteral dilation, duplex kidney, solitary kidney, fusion anomalies, VUR, ureterocele, PUV, and SFU grade IV hydronephrosis were excluded. The primary outcome parameter was complete resolution of hydronephrosis that was achieved via two consecutive renal US results with RPAPD < 7 mm and SFU grade 0. Ultrasonography results that were obtained within first 48 h of life were also excluded. Age at the time of initial postnatal renal US, gender, laterality, urinary tract infection (UTI), urolithiasis, and follow-up period were noted. Radiologists performed all imaging studies. RPAPD was measured at the hilum on transverse plane. Stable hydronephrosis is described as no increase or decrease in SFU grading and RPAPD. Urinary tract infection was further investigated in patients with pyuria (> 5 leucocytes/HPF) in urine specimens collected via urethral catheterization, and it was defined as $> 10,000$ CFU/ml growth of a single bacterial pathogen in samples collected as described. Antibiotic prophylaxis was not initiated routinely, however; those patients who were diagnosed with UTI were placed under antibiotic prophylaxis until a voiding cystourethrography is obtained. Numbers of patient visits were also noted.

The indications of referral to surgery were initially impaired ipsilateral split renal function ($< 40\%$), $> 10\%$ decrease of split renal function in subsequent studies, constantly

Table 1 Initial patient characteristics

	Frequency (n)	Percentage (%)
Gender		
Male	215	77.9
Female	61	22.1
Laterality of hydronephrosis		
Left	201	73
Right	39	14
Bilateral	36	13
Renal pelvis AP diameter		
< 10 mm	137	49.6
10–20 mm	139	50.4
SFU Grade		
SFU I	157	50.3
SFU II	132	42.3
SFU III	23	7.4

AP anteroposterior, SFU Society for Fetal Urology

increasing RPAPD on US as well as presentation of ipsilateral flank pain, history of pyelonephritis, and renal stones due to obstruction.

In statistical analysis, the normality of distribution of continuous variables was tested by Shapiro-Wilk test. Mann-Whitney *U* was used for comparison of two independent groups of variables with a non-normal distribution, and Kruskal-Wallis and Dunn multiple comparison tests were used to compare three groups in terms of non-normal data. Chi-square test was used to investigate relationship between categorical variables. Cumulative spontaneous resolution of hydronephrosis was evaluated using Kaplan-Meier analysis, and differences between subgroups were assessed by two-sided log-rank test. Factors predicting spontaneous resolution

Table 2 Outcome of patients as per RPAPD for hydronephrosis

Parameter	RPAPD < 10 mm	RPAPD 10–20 mm	<i>p</i>
Spontaneous resolution (%)	127 (92.7)	71 (51.1)	< 0.001
Time to resolution (months)	5.0 (2–29)	11.0 (2–35)	< 0.001
Stable hydronephrosis (%)	8 (5.8)	61 (43.9)	0.001
Progression of HN (%)	2 (1.5)	7 (5)	0.173
Follow-up period (months)	11.0 (3–69)	19.0 (3–67)	–
Urinary tract infection (%)	19 (14.1)	21 (14.9)	0.960
Urolithiasis (%)	10 (7.4)	25 (17.7)	0.008

RPAPD renal pelvis anteroposterior, HN hydronephrosis

Table 3 Outcome of patients as per SFU Grading for hydronephrosis

Parameter	SFU I	SFU II	SFU III	<i>p</i>
Spontaneous resolution (%)	140 (89.2)	75 (56.8)	8 (34.8)	0.001
Time to resolution (months)	5.0 (2–33)	9.0 (2–34)	12.0 (11–35)	0.001
Stable HN (%)	15 (9.6)	52 (39.4)	15 (65.2)	0.001
Progression of HN (%)	2 (1.3)	7 (5.3)	–	NA
Follow-up period (months)	12.0 (3–69)	18.0 (3–66)	16.0 (3–75)	–

SFU Society for Fetal Urology, HN hydronephrosis

were assessed using Cox proportional hazard models. Data were analyzed using IBM SPSS 24.0 software, and a *p* value < 0.05 was accepted as statistically significant.

Post hoc power analysis was performed by using G power package version 3.1.9.2.

Results

Out of 618 patients, 276 patients were eligible for the study. A total of 226 patients were excluded due to RPAPD < 7 mm or 20 mm in the initial renal US or insufficient data, 87 patients due to VUR, 17 patients due to primary megaureter, 7 patients due to ureterocele, and 5 patients due to PUV. Sixty-one were females (22.1%) and 215 were males (77.9%). Median age at

the time of first renal US was 30 days (range 3–120 days). Moreover, median follow-up period was 16 months (IQ range 3–96 months). Hydronephrosis was left sided in 201 patients (73%), right sided in 39 (14%), and bilateral in 36 (13%) (Table 1).

Patients were divided into two groups according to RPAPD for better assessment of results. Cut-off was set as 10 mm in order to obtain similar number of patients. RPAPD was < 10 mm in 137 patients (49.6%), while it was 10–20 mm in 139 (50.4%). Hydronephrosis completely resolved in 198 patients (71.7%). Spontaneous resolution rate was 92.7% in RPAPD < 10 mm group (*n* = 127), while it was 51.1% (*n* = 71) in the RPAPD 10–20 mm group. Degree of hydronephrosis remained stable in 69 patients (25%), and there was progression in 9 patients (3%). However, no patients in our cohort required surgery during the follow-up period (Table 2).

Of the 312 renal units initially assessed as per SFU grading system, 157 were grade I (50.3%), 132 were grade II (42.3%), and 23 were grade III (7.4%). Complete resolution was observed in 221 renal units (70.8%). Further, 89.2% with SFU grade I, 56.7% of SFU grade II, and 34.3% of SFU grade III patients showed complete resolution. (Table 3).

Median time to resolution was 6 months (IQ range = 2–35 months) in the total cohort. In patients with RPAPD < 10 mm, median time to resolution was 5 months (IQ range = 2–29 months), whereas median time to resolution was 11 months (IQ range = 2–35 months) in patients with RPAPD 10–20 mm. The difference between these two groups was statistically significant (*p* < 0.001). Median number of

Fig. 1 Kaplan-Meier curves with regard to spontaneous resolution in patients with renal pelvis AP diameter < 10 mm and 10–20 mm

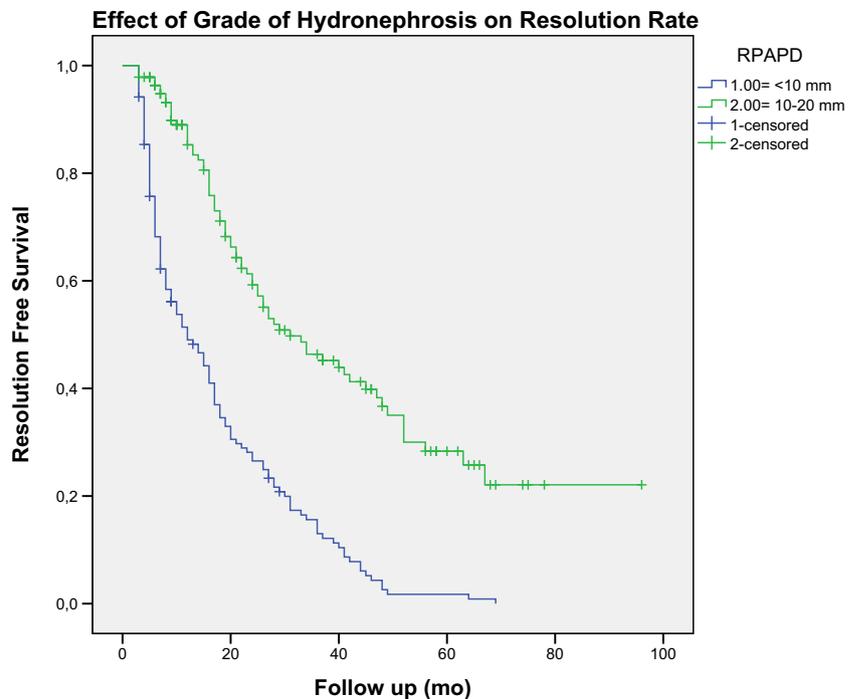
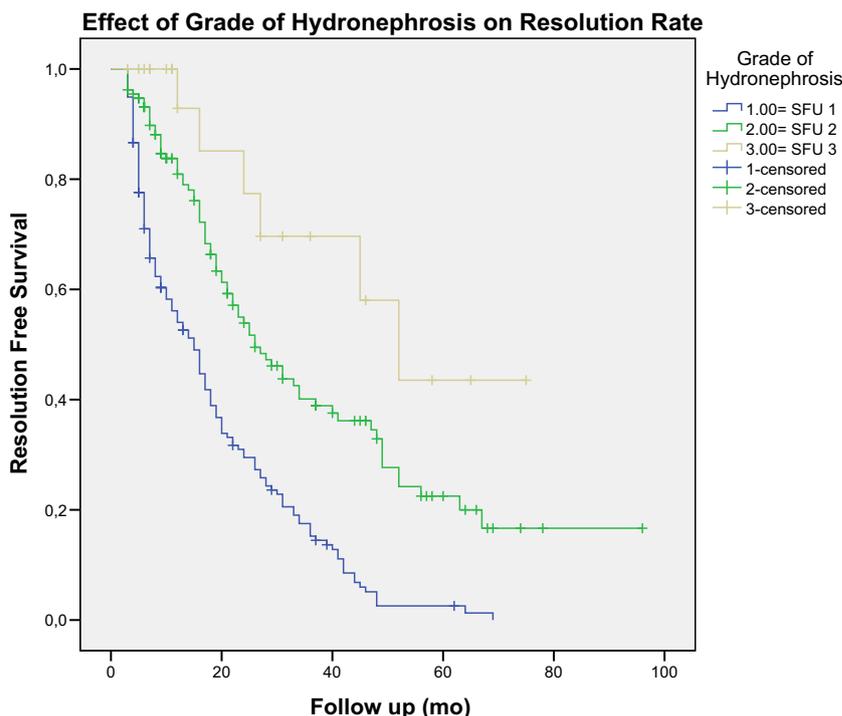


Fig. 2 Kaplan-Meier curves of spontaneous resolution in the patient cohort as per SFU grading system



clinical visits was 4 in the RPAPD < 10 mm group, while it was 6 in the RPAPD 10–20 mm group ($p = 0.02$).

Within follow-up period, UTI was diagnosed in 40 patients (14.5%) and urolithiasis was found in 35 patients (12.7%). RPAPD did not affect incidence of UTI ($p = 0.960$). However, UTI was statistically more frequent in girls (32.8% vs. 9.3%, $p < 0.001$). Urolithiasis was found more frequent in RPAPD 10–20 mm group (10 (7.4%) vs. 25 (17.7%), $p = 0.008$). Additionally, 46 patients (17%) in the cohort required scintigraphic assessment, and 86 patients (31%) underwent voiding cystourethrography (VCUG). None of the patients that required scintigraphic evaluation were excluded due to reduced differential renal function (< 40%).

Kaplan-Meier survival analysis results indicated that lower RPAPD and lower SFU grades would require shorter time for resolution ($p < 0.001$) and also, resolution time of all patients

predicted a median of 20 ± 1.6 months (CI 16.8–23.1) for complete resolution. (Figs. 1 and 2). Cumulative spontaneous resolution probabilities in years as per RPAPD and SFU grading system are given in Tables 4 and 5. Univariate Cox regression analysis results showed that follow-up period in addition to RPAPD and SFU grade could predict spontaneous resolution (Table 6). Post hoc power based on RPAPD was calculated as 89.6% and 93.3% for SFU grading.

Discussion

Postnatal evaluation of prenatally detected hydronephrosis is a growing entity in pediatric urology and nephrology clinics. Ultrasonography is the mainstay of evaluation where additional imaging techniques are required in selected patients. In this

Table 4 Cumulative spontaneous resolution probabilities in years per RPAPD

Follow-up years	RPAPD < 10 mm (% ± SE)	RPAPD 10–20 mm (% ± SE)
1	51.0 ± 4.4	14.7 ± 3.2
2	74.0 ± 3.9	40.7 ± 4.8
3	87.0 ± 3.1	54.8 ± 5.0
4	97.4 ± 1.5	63.3 ± 5.1
5	99.1 ± 0.9	74.2 ± 5.3

Log rank $p = 0.001$ for overall spontaneous resolution of hydronephrosis RPAPD renal pelvis anteroposterior diameter

Table 5 Cumulative spontaneous resolution probabilities in years per SFU grading

Follow-up years	SFU grade I (% ± SE)	SFU grade II (% ± SE)	SFU grade III (% ± SE)
1	51.0 ± 4.4	16.1 ± 3.6	7.1 ± 6.9
2	72.7 ± 3.9	44.6 ± 5.3	22.6 ± 1.2
3	84.8 ± 3.1	61.1 ± 5.0	30.2 ± 1.6
4	97.4 ± 1.4	67.1 ± 5.1	42.0 ± 1.5
5	98.7 ± 1.2	75.5 ± 5.1	56.5 ± 1.7

Log rank $p = 0.001$ for overall spontaneous resolution of hydronephrosis SFU Society for Fetal Urology

Table 6 Univariate Cox proportional hazard analyses of predictive factors for resolution of antenatal hydronephrosis

Variables	HR	95% CI	<i>p</i> value
RPAPD	0.43	0.32–0.59	< 0.001
SFU I	Reference	–	–
SFU II	0.37	0.27–0.50	< 0.001
SFU III	0.17	0.08–0.39	0.001
Follow-up period	0.69	0.65–0.76	0.001
Gender	1.10	0.79–1.52	0.578
Right side	Reference	–	–
Left side	1.35	0.89–2.05	0.162
Bilaterality	1.34	0.76–2.38	0.315

HR hazard ratio, CI confidence interval, RPAPD renal pelvis anteroposterior diameter, SFU Society for Fetal Urology

study, we stratified our cohort of hydronephrosis using RPAPD and SFU grading systems and aimed to address time to spontaneous resolution.

In a recent report of 192 patients, resolution of mild hydronephrosis was 97%, where it was 78% in moderate hydronephrosis in a median follow-up of 24 months [6]. Another study looked into 322 patients, resolution was observed slightly over 90% in SFU I–II grades and 75% in SFU grade III during mean 22 ± 19 months [3]. Tombesi et al. showed 73% resolution rate in 193 newborns with RPAPD 5–15 mm in the first year [15]. Moreover, it has been reported that isolated bilateral mild hydronephrosis has become normalized in 80% within 1 year [1]. Similarly, our results indicate 71.7% of complete resolution within median 16 months of follow-up period. Additionally, time to resolution was statistically significantly shorter in patients with RPAPD < 10 mm vs. RPAPD 10–20 mm.

Our results of survival analysis indicate that only RPAPD, SFU grading, and follow-up period would predict spontaneous resolution where lateralization or gender would not. In a prospective evaluation data of the SFU hydronephrosis registry, the authors have found that resolution rate (described as SFU grade 0) is 29% for SFU grade I and 25% for SFU grade II in median 15 months (IQR 7–24 months) [17]. In addition, Braga et al. have found a cumulative resolution rate of 98% for SFU grade I, 87% for SFU grade II and 76% for grade III in 3 years [4]. However, both papers have included VUR and primary megaureter as etiologies for hydronephrosis. In our cohort of UPJO like hydronephrosis, median time for complete resolution was 6 months. Besides, Kaplan-Meier survival analysis considering spontaneous resolution time of all patients predicted a median of 20 ± 1.6 months for complete resolution. Also, it has been calculated that $56.5 \pm 1.7\%$ spontaneous resolution rate may be expected in patients with initial SFU grade III hydronephrosis in 5 years.

Given the very low risk of progression, patients with RPAPD < 10 mm would require follow-up for at least 3 years

whereas patients with RPAPD 10–20 mm for 5 years. A follow-up schedule such as 0, 3, 6, and 12 months for the first year and twice a year/annually may be applicable to reduce cost and decrease unnecessary clinical visits. Also, we believe that patients with two consecutive normal renal US during follow-up could be discharged.

Studies have shown that resolution for initial RPAPD > 20 mm is unlikely [1, 2, 7]. In parallel, RPAPD > 15 mm has been suggested for further evaluation (i.e., scintigraphy) [6, 15]. In our cohort, we found no patients with initial RPAPD \leq 20 mm or SFU grade III required surgery. According to our results, we think that further scintigraphic evaluation may not be necessary in all patients with initial RPAPD \leq 20 mm or SFU grade III. There is also a recent study that suggests 20 mm would be the new threshold for further imaging [14].

In our study, we found urolithiasis in 7.4% of the patients with RPAPD < 10 mm and 17.7% in patients with RPAPD 10–20 mm. However, clinical significance of this finding remains unclear. UTI rates in our cohort (14.5%) were similar to previous studies [6, 15]. However, our data lacks the circumcision status, which is known to have an impact on UTI rates.

Main limitation of our study is its retrospective nature. However, we believe that our data reflects a more realistic population data with approximately 12,000 births/year in our center compared to tertiary centers, which take care of complicated/referred patients. Additionally, interobserver variability of US results is a limitation [5]. On the other hand, our definition of complete resolution is robust as it includes two consecutive normal renal US results that are SFU grade 0 and RPAPD < 7 mm.

Conclusions

Isolated antenatal hydronephrosis with RPAPD \leq 20 mm would spontaneously resolve in approximately 72% of the cases. Resolution may be expected to happen in 3 years, while the majority will take place in the first year of life. Patients with RPAPD < 10 mm require a shorter period for spontaneous resolution than those with RPAPD 10–20 mm.

Acknowledgments We would like to thank Amanda F. Saltzman, MD (Children's Hospital Colorado), for kindly reviewing the manuscript.

Authors' contributions AME collected and analyzed data, wrote the manuscript. MID analyzed the data, wrote and critically revised the manuscript. Both authors read and approved the final version of the manuscript.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical standards All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

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