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Program For Diagnosing The Degree Of Urodynamic Disorders And Kidney Functions And Determining Tactics Of Managing Children With Obstructive Uropathies.

Short running title:
ULTRASONIC VISUALIZATION OF OBSTRUCTIVE UROPATHIES IN CHILDREN

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Abstract
Background: The objective of the study is to develop a program of scoring for determining the degree of impairment of urodynamics and the preservation of renal function in children with obstructive uropathy on the basis of data from ultrasound - Doppler studies.
Methods: The work is based on the results of ultrasound and Doppler examination of 484 children with congenital obstructive uropathy. In accordance with the obtained data, a point assessment of the degree of impairment of urodynamics and preservation of renal function was carried out in 60 children with obstructive uropathies (30 children with congenital hydronephrosis and 30 children with congenital ureterohydronephrosis).
Results: Analysis of ultrasound and Doppler studies in congenital obstructive uropathy in children by comparing the data, depending on the severity and level of obstruction, revealed 3 degrees of congenital obstruction of the upper urinary tract in children. A comparative study of the urodynamics and state of the renal parenchyma, depending on the degree of obstruction, established a close relationship between the indicators of the functional state of the renal parenchyma and the degree of dilatation and disorders of the urodynamics of the upper urinary tract.
Conclusion: The developed program allows the safe and most informative methods to reliably determine the functional state of the renal parenchyma and the degree of urodynamic impairment in children with obstructive uropathy. Study Registration (ClinicalTrials.gov) ID NCT04605835.
Keywords: obstructive uropathy, children, ultrasound, Doppler.

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What is known

- Most researchers point out that Doppler sonography, properly understood, can be a useful clinical tool in the hands of the clinician.
- A more complex functional approach may allow Doppler ultrasound to play a leading role in the imaging assessment of urodynamic impairment and kidney damage in congenital obstructive diseases in children.

What's new

- The data of ultrasound-Doppler studies in children with obstructive uropathy were studied, depending on the level and severity of obstruction.
- The analysis of the results of ultrasound-Doppler studies, which made it possible to establish the degree of obstruction of the upper urinary tract in children, taking into account the functional state of the kidneys, depending on the level and degree of urodynamic impairment.
- A program has been developed for scoring the results of ultrasound Doppler studies to determine the degree of impairment of urodynamics and the preservation of renal function in children with obstructive uropathy.

LIST OF ABBREVIATIONS

CH - congenital hydronephrosis
PWDG - pulse-wave Doppler
PUS - pelvic-ureteric segment
ICD - international classification of diseases
UVE - ureterovesical ejection
MU - megaureter
mm - millimeter
m/s - meters per second
OU - obstructive uropathy
RPT - renal parenchyma thickness
RMU - refluxing megaureter
sec - seconds
Ultrasound - ultrasound examination
CDM - color Doppler mapping
RI - resistance index
PI - Purselot index
ICD - nternational classification of the disease

1. INTRODUCTION

In the nosological structure of chronic renal failure in children, malformations of the organs of the urinary system range from 30% to 80%, of which about 43% are obstructive uropathies, i.e. defects with impaired urodynamics (1, 3, 5). OUs are the main reason for the loss of kidney function in children, especially infants and young children, which makes this problem one of the socially significant ones (2, 4, 6).

The modern diagnostic process in relation to obstructive uropathies is focused on the effect (the degree of expansion and delay in the emptying of the ureter and pelvis). However, early diagnosis of the degree of impairment of renal function and impairment of urodynamics plays an important role (7, 8, 9). Considering that we are talking about children, the issue of predicting the development of these diseases becomes especially important, even at that stage of the pathological process, when the functional abilities of the kidneys and upper urinary tract are preserved (1, 5, 8).

One of the most informative methods for assessing renal blood flow is color Doppler mapping and pulse wave Doppler imaging (3, 8, 10).

Purpose of the study. On the basis of the data of ultrasound - Doppler studies, develop a program for scoring to determine the degree of impairment of urodynamics and preservation of renal function in children with OU.

2.MATERIAL AND METHODS

2.1. Study Center

A prospective, controlled clinical study was carried out at the Department of Pediatric Surgery No. 2 of the Samarkand State Medical Institute in the Regional Children's Multidisciplinary Medical Center in Samarkand, Republic of Uzbekistan for the period from 2003 to 2019 years.

2.2. Ethical Consideration

The study was approved by the Medical Ethics Committee of the Ministry of Health of the Republic of Uzbekistan in accordance with the Declaration of Helsinki. Both informed and written consents were obtained from the parents or from appropriate relatives or guardians of the patients and healthy individuals of the control group. The trial is registered at the US National Institutes of Health (ClinicalTrials.gov ID NCT04605835. 21.10.2020).

2.3. Participants

The work is based on the results of examination and treatment of 484 children with congenital obstructive uropathy. In ICD 10, obstructive uropathy is associated with tubulointerstitial kidney disease and has code N13 (obstructive uropathy and reflux uropathy). Of the total number of patients, 301 patients (distribution of children by sex and age presented in Table 1) with kidney damage and impaired urodynamics of the upper urinary tract had hydronephrosis (ICD code Q62.0 - congenital hydronephrosis and N13.6 - hydronephrosis with obstruction LMS).

In 183 children (the distribution of children by sex and age is presented in Table 2), a megaureter was diagnosed (ICD code Q62.2 - Congenital ureteral dilatation [congenital megaloureter], Q62.7 - Congenital vesicoureteral-renal reflux, N13.4 - Hydroureter).

2.4 Ultrasonography

Ultrasound examination of the kidneys and urinary tract was performed using an ultrasound diagnostic unit Toshiba Xario 200 with a convex and linear transducer with a Doppler 3.75, 8 MHz. The anatomy of the excretory system and the degree of dysfunction of the pelvis of the affected kidney were consistently assessed. To do this, using echography, the thickness of the renal parenchyma, the size of the pelvis, the size of the enlarged calyx, the size of the affected and contralateral kidney, and the state of the ureter of the affected kidney were determined.

2.5 Pulse-wave Doppler sonography

Before and after the operation, at different times, the ultrasound examination of the patients included a study in the B-mode, the ureteral-cystic urine output was determined using pulse-wave Doppler ultrasonography. The resulting Dopplerogram was evaluated qualitatively: its shape was determined, and quantitatively: the number of ejections per minute, the duration of one ejection, its minimum, average and maximum speeds were calculated.

2.6 Color Doppler sonography

Color Doppler mapping at the levels of the main trunk and segmental vessels of the kidney was performed using a Sono Scape SSI-5000 ultrasound device with a Doppler attachment using convex probes 3.5-5 MHz. The objective criteria for renal blood flow were independent indicators of blood flow - pulsation index (PI) and resistance index (RI) or Purselot index

Based on the data obtained, the scoring of the degree of impairment of urodynamics and preservation of renal function was carried out in 60 children with obstructive uropathies (30

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children with congenital hydronephrosis and 30 children with congenital ureterohydronephrosis). Functionality of the program: drawing up a card of the examined patient, collecting, entering, saving data on ultrasound-Doppler studies.

2.7 Statistical analysis

The data obtained during the study were subjected to statistical processing on a Pentium-IV personal computer using the Microsoft Office Excel-2012 software package, including the use of built-in aggregation functions. Methods of variational parametric and nonparametric statistics were used with the calculation of the arithmetic mean of the studied indicator (M), standard deviation (s), standard error of the mean (m), relative values (frequency,%), the statistical significance of the measurements obtained when comparing the mean values was determined by the criterion Student's t (t) with the calculation of the error probability (P) when checking the normal distribution (by the kurtosis criterion) and the equality of the general variances (F is the Fisher test). The level of reliability $P < 0.05$ was taken as statistically significant changes. Statistical significance for qualitative values was calculated using the $\chi 2$ test (chi-square) and z-test.

3 RESULTS AND ITS DISCUSSION

3.1 Condition of the renal parenchyma

With hydronephrosis, following the expansion of the CPS, the linear dimensions of the kidney itself increase. With congenital megaureter, following the expansion of the ureters and CPS, there is an increase in the linear dimensions of the kidney, as well as lengthening and tortuosity of the ureter.

In children with congenital OU, the analysis of the size of the RPT revealed that, depending on the degree of obstruction in all age groups, the renal parenchyma becomes thinner. As can be seen from the table, the difference between the indicators is significant and has a significant difference $p \leq 0.001$ (table 3). In this regard, for the convenience of data interpretation, we subsequently used the average age values of RPT.

One of the most informative methods for assessing renal blood flow is color Doppler mapping and pulse wave Doppler imaging. To identify the criteria for assessing the functional state of the kidneys using color Doppler mapping, the parameters of renal parenchymal blood flow were studied.

With congenital obstruction of the upper urinary tract of the II degree, the echogenicity of the parenchyma was increased, differentiation was reduced. With CDM, the blood flow was significantly depleted. Hemodynamics in all children at the level of the renal artery trunk and segmental branches was not disturbed, at the level of interlobar branches the IR was increased; at the level of the arc arteries, it decreased. In grade III congenital UHN and CH, the parenchyma was highly echogenic and not differentiated. At CDM, single color signals were determined, the usual pattern of the kidney tree was not determined.

3.2 Assessment of impairment of the degree of urodynamics

To study the degree of impairment of the urodynamics of the upper urinary tract in children with congenital OU, we analyzed the data of the PWDG of the urinary urinary tract, depending on the type and degree of obstruction. In case of CH and obstructive MU of the I-degree, the Doppler study had the form of one or two wave ejections. For CH and congenital obstructive MU of the II degree, a Doppler study in the form of a single-wave ejection having an intermittent nature was characteristic. At grade III, the ejection was of the venous type, short-lived.

Ureterovesical urine output in grade II-III refluxing ureterohydronephrosis has attracted some interest. In grade II, the ejection was two-wave and venous. At grade III, the ejection was venous, continuous - almost constant.

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In order to study the anatomical and functional state of the renal parenchyma and upper urinary tract in children with congenital OU, the results of ultrasound data were analyzed. To do this, depending on the degree and level of obstruction, such parameters of ultrasound scanning as RPT, average velocity, frequency and duration of ureteral-cystic urine output, as well as indicators of renal parenchymal blood flow - pulsation index (PI) and resistance index (RI) were compared or Purselot index (table 4). In children with congenital refluxing MU, such indicators of ultrasound as RPT, IR (renal arteries) were identical to those in children with CH and congenital obstructive MU.

At the 1st degree of obstruction, the sizes of the renal parenchyma thickness with the normative data are not significantly different. At II and III degrees - as a result of an increase in hydrostatic pressure in the cavity system of the organ, the renal parenchyma atrophies, $p \leq 0.05$ and $p \leq 0.001$, respectively. In children with I

degree of obstruction during dopplerometry of the vascular bed of the renal parenchyma, the resistance index values practically did not differ from the standard indicators.

As can be seen from table 4, at grade II - there was an increase in the resistance index (compared to the norm) both in the interlobar and in the segmental arteries. However, the difference was not significant. Doppler indices of the resistance index of renal parenchymal blood flow in congenital obstructive uropathies with grade 3 obstruction were significantly higher than the normative data $p \leq 0.001$ and more than in children with grade 2 obstruction, with no significant difference.

Analysis of the results of PWDG of ureterovesical urinary ejection in congenital obstructive uropathies, depending on the degree of obstruction, revealed that with I degree of obstruction, the average urinary ejection rate did not practically differ from the norm. It significantly decreased with an increase in the degree of obstruction, $p \leq 0.01$ for grade II and $p \leq 0.001$ for grade III obstruction. The time for one ureterovesical urinary ejection also decreased depending on the degree of obstruction. Already with the I degree of obstruction of the upper urinary tract there was a significant difference in comparison with the norm $p \leq 0.05$, with the II and III degrees the difference in indicators was more significant $p \leq 0.001$.

PWDG of ureterovesical ejection in children with refluxing mucosa revealed a characteristic difference in this category of patients (Table 5).

Table 5 shows that with II and III degrees of refluxing MU, the average urinary ejection rate with normative data is reliable in the difference between $p \leq 0.05$ and $p \leq 0.01$, respectively, but it is less significant than with obstructive MU and CH. The time of one ejection at the II degree of refluxing MU practically does not differ from the norm, and at the III degree $p \leq 0.001$ significantly increases.

4. DISCUSSION

Considering that in pediatric practice it is necessary to strive to reduce the number of more invasive or radiation and relatively expensive studies, a scoring program was developed to determine the degree of impairment of urodynamics and preservation of renal function in children with OU (Table 6).

4 points - normal, no obstruction, urodynamics not impaired, kidney function unchanged. Observations by a pediatrician at the place of residence. Urine analysis once a year

4-8 points - 1 degree of obstruction, urodynamics does not suffer, kidney function is preserved. Observations by a pediatric urologist at the place of residence. Delivery of urine tests 2 times a year. If necessary, conservative therapy.

8-12 points - 2 degree of obstruction, moderate urodynamic impairment, reversible changes in the renal parenchyma, renal function does not suffer significantly. Hospitalization in a children's surgical hospital. Reconstructive plastic surgery on the upper urinary tract.

12-16 points - 3 degree of obstruction, contractility of the ureter is practically absent, irreversible changes in the renal parenchyma, renal function is affected, possibly the development of nephrosclerosis. Hospitalization in a children's surgical hospital. Radiological examination of the kidneys. Reconstructive plastic surgery on the upper urinary tract is possible organ-removal surgery.

5. CONCLUSION

Given the tenderness of the growing body of a suffering child, preference should be given to diagnostic methods that are safe for the child's body.

Ultrasound examination is a highly informative diagnostic method that combines the functions of imaging and radiation protection. The proposed criteria will allow clinicians to abandon invasive methods of examination of congenital diseases of the kidneys and urinary tract.

Ultrasound imaging of the anatomy and function of the kidneys justifies the use of Doppler imaging for congenital upper urinary tract obstruction. The developed program can help to reliably determine the functional state of the renal parenchyma and the degree of urodynamic disturbance in children with OU using minimally invasive and most informative methods.

He program can be used in practical medicine, in particular, pediatrics, pediatric urology and pediatric surgery to improve the diagnosis of obstructive uropathy. Assessment of the functional state of the kidneys and ureters will help predict the course of the disease and prevent the development of nephrosclerosis and chronic renal failure in children.

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REFERENCES

[1] de Bessa J, Jr, Dénes FT, Chammas MC, Cerri L, Monteiro ED, Buchpiguel CA. Diagnostic accuracy of color Doppler sonographic study of the ureteric jets in evaluation of hydronephrosis. J Pediatr Urol. 2008;4:113–7. [PubMed] [Google Scholar]

[2] Piazzese EM, Mazzeo GI, Galipò S, Fiumara F, Canfora C, Angiò LG, et al. The renal resistive index as a predictor of acute hydronephrosis in patients with renal colic. J Ultrasound. 2012; 15:239–46. [PMC free article] [PubMed] [Google Scholar]

[3] Kiliç S, Altinok MT, Ipek D, Beytur A, Baydinç YC, Güneş G, et al. Color Doppler sonography examination of partially obstructed kidneys associated with ureteropelvic junction stone before and after percutaneous nephrolithotripsy: Preliminary report. Int J Urol. 2005;12:429–35. [PubMed] [Google Scholar]

[4] Szymanski KM, Al-Said AN, Pippi Salle JL, Capolicchio JP. Do infants with mild prenatal hydronephrosis benefit from screening for vesicoureteral reflux? J Urol. 2012;188:576–81. [PubMed] [Google Scholar]

[5] Keays MA, Guerra LA, Mihill J, Raju G, Al-Asheeri N, Geier P, et al. Reliability assessment of society for fetal urology ultrasound grading system for hydronephrosis. J Urol. 2008;180:1680–2. [PubMed] [Google Scholar]

[6] Hashim H, Woodhouse CR. Ureteropelvic junction obstruction. Eur Urol Suppl. 2012;11:25–32. [Google Scholar]

[7] Longpre M, Nguan A, Macneily AE, Afshar K. Prediction of the outcome of antenatally diagnosed hydronephrosis: A multivariable analysis. J Pediatr Urol. 2012; 8:135–9. [PubMed] [Google Scholar]

[8] Maryam R, Amir H, Alaleh G, Omid Sh, Alireza M, Mehdi K, Maryam F, and Masoud M. How may Doppler indices help in the differentiation of obstructive from nonobstructive hydronephrosis? J Res Med Sci. 2018; 23: 76. [PubMed] [Google Scholar]

[9] I. N. Apoku , O. O. Ayoola , A. A. Salako, B. M. Idowu. Ultrasound evaluation of obstructive uropathy and its hemodynamic responses in southwest Nigeria. Int. braz j urol. vol.41 no.3 Rio de Janeiro May/June 2015

[10] Chung-Chieng Wu. Ureteric Jet. Journal of Medical Ultrasound Volume 18, Issue 4, December 2010, Pages 141-146

[11] Nargiz N. Shavazi, Vyacheslav I. Lim, Nurali M. Shavazi. Influence of Threats of the Preterm Birth to the Intra and Postnatal Periods of Infants. Journal of Advance Research in Dynamical & Control Systems, Vol. 12, No. 5, 2020. P. 210-215

Table 1.Distribution of children with congenital hydronephrosis depending on the degree, age and gender

degree	Up to 1 year		1-3 years		3-7years		7-11years		More than 11-15years		Total
	b	g	b	g	b	g	b	g	b	g	
I	3	-	1	3	1	3	4	1	4	3	23
II	5	-	12	2	12	11	7	4	19	9	81
III	25	4	28	5	27	11	44	15	27	11	197
Total	33	4	41	10	40	25	55	20	50	23	301
%	12%		17%		22%		25%		24%		100%

Table 2.
Distribution of children with congenital megaureter depending on degree, age and gender

Obstructive megaureter											
degree	Up to 1 year		1-3years		3-7years		7-11years		More than 11-15years		Total
	b	g	b	g	b	g	b	g	b	G	
I	-	-	-	-	-	-	-	-	-	-	
II	1	-	7	2	4	3	3	3	3	-	26
III	16	1	8	5	10	6	9	2	6	5	68
Reflux megaureter											
I	-	-	-	-	-	1	-	2	1	1	5
II	2	2	3	4	2	5	1	-	4	4	27
III	4	8	5	7	4	7	4	5	5	8	57
Total	23	11	23	18	20	22	17	12	19	18	183
%	19%		22%		23%		16%		20%		100%

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Table 3.RPT values (mm) according to ultrasound data in children with congenital OU depending on age and degree of obstruction

	I degree (n-28)	II degree (n-134)	III degree (n-322)
0-3 years	13,5±1,5 (n-7) ***	12,6±1,6 (n-40) ***	8,9±1,3 (n-116)
3-7 years	14,2±1,3 (n-5) ***	13,1±1,4 (n-37) ***	11,2±1,3 (n-65)
7-11 years	15,5±1,5 (n-7) ***	14,7±1,5 (n-18) ***	10,6±1,5 (n-79)
11-15 years	17,2±1,7 (n-9) ***	15,5±1,3 (n-39) ***	9,5±1,6 (n-62)
Mean	15,1±1,5 ***	13,9±1,4 ***	9,9±1,4

p≤0,001***

Table 4.Ultrasound indices in children with congenital OU depending on the degree of obstruction

	RPT (mm)	IR (renal arteries)	Mean MPV urine speed (m/s)	Time of one urine MPV (sec)
Norm	18,5±1,5	0,63±0,05	0,24±0,02	5,1±0,3
I degree obstruction	15,1±1,5 (n-28)	0,63±0,05 (n-4)	0,22±0,01 (n-4)	4,1±0,3 (n-4)*
II degree obstruction	13,9±1,5 (n-134) *	0,73±0,05 (n-10)	0,13±0,03 (n-47) **	2,3±0,8 (n-47) ***
III degree obstruction	9,9±1,5 (n-322) ***	0,80±0,05 (n-20) ***	0,07±0,01 (n-91) ***	1,7±0,8 (n-91) ***

p≤0,05*, p≤0,01**, p≤0,001***

Table 5.Indicators of ureterovesical urine output in children with refluxing mu

	Mean UVE urine speed (m/s)	Time of one urine UVE (sec)
Norm	0,24±0,02	5,1±0,3
Reflux MU 2 degree (n-10)	0,19±0,01 *	4,3±0,8
Reflux MU 3 degree (n-16)	0,13±0,02 **	6,3±0,2 ***

p≤0,05*, p≤0,01**, p≤0,001***

Table 6.Diagnostic program for the degree of renal dysfunction and urodynamics

№	Indicators	Meanings	Scores
1	TRP (mm) - the thickness of the renal parenchyma according to ultrasound	18-22	1
		15-17	2

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		12-14	3
		5-11	4
2	AVUUO (m / s) - the average velocity of the ureterovesical urine output according to Doppler ultrasonography	0,23-0,25	1
		0,20-0,23	2
		0,10-0,18	3
		0,06-0,09	4
3	t (sec) - time of one uretero-vesical urine output according to Doppler ultrasound	4,8-5,5	1
		3,9-4,5	2
		1,9-3,5	3
		0,9-1,8	4
4	RD - the ratio of the difference between the maximum systolic velocity and the final diastolic to the maximum systolic velocity, renal blood flow according to Doppler ultrasonography.	0,56-0,62	1
		0,63-0,67	2
		0,68-0,75	3
		0,76-0,85	4