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The value of the ultrasound score to indicate pyloplasty in unilateral hydronephrosis: a retrospective study with 120 Brazilian children

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Abstract: Introduction: Scintigraphy has long been the gold standard for indicating pyeloplasty for UPJO. The Pyeloplasty Prediction Score (PPS) was introduced as an alternative tool to indicate pyeloplasty. Ultrasound is widely available, painless, noninvasive, does not require radiation, and is a low-cost examination. This study evaluates the correspondence between PPS and patients who underwent pyeloplasty. **Method:** This was a retrospective study involving 120 patients who underwent pyeloplasty. After data collection, the researchers applied the PPS. **Results & Discussion:** The left kidney was the most commonly affected (68.3%), mainly in boys (67.5%), and 49.2% received an antenatal diagnosis. Intrinsic obstruction was found in 89.7% of the patients. Approximately 69.17% (n=83) had a preoperative PPS grater/equal 8. The affected kidney had a larger longitudinal measure than the contralateral. There was no difference related to sex, laterality, or etiology. The use of the ultrasound score would be sufficient for almost 70% of patients to indicate pyeloplasty without any other complementary exams. **Conclusions:** Based on this study, it is not possible to state

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that the PPS, without kidney scintigraphy, is effective in indicating pyeloplasty for every patient. However, it could be an excellent screening method.

Keywords: Hydronephrosis. Ultrasonography. Ureteral obstruction. Urogenital abnormalities. Pediatrics.

Introdução

Approximately 0.5% of pregnancies have malformations detected prenatally, and 20-50% are in the genitourinary tract. The primary manifestation is hydronephrosis, especially in the third trimester.[1,2]

Among patients with antenatal hydronephrosis, 44–65% are diagnosed with ureteropelvic junction (UPJ) obstruction after birth.[1] However, more than 50% of patients with mild or moderate hydronephrosis improve without surgical intervention.[2] Currently, the indications for surgery are based on clinical and radiologic criteria, including loss or worsening of kidney function, clinical symptoms, and bilateral obstruction. Generally, when the estimated kidney function is greater than 45%, a conservative approach is chosen.[3]

The Pyeloplasty Prediction Score (PPS) is a classification system for hydronephrosis that is based solely on ultrasound. A score equal to or greater than eight suggests severe hydronephrosis, which is likely associated with ureteropelvic junction obstruction (UPJO-like).[4]

Clinical Implications

The PPS was applied in the Canadian population. However, other heterogeneous populations, such as the Brazilian population, have largely not been studied. This study aimed to evaluate the PPS in children undergoing pyeloplasty at a large tertiary urological reference center in Brazil. The use of the PPS could contribute to a faster and more effective definition of conduct, sparing nephrons and avoiding delays in treatment.

Methods

The Ethics and Research Committee of the pediatric hospital located in Curitiba, Paraná, Brazil, approved this project. The protocol numbers are 4,268,284 and 6,197,969.

This was a retrospective study with patients who underwent pyeloplasty between July 2012 and December 2022. The study included all patients who underwent pyeloplasty for UPJO

and were up to 18 years of age. The patients excluded were those with other genitourinary conditions (vesicoureteral reflux, megaureter, duplication, posterior urethral valve, horseshoe kidneys, multicystic renal dysplasia, neurogenic bladder, voiding dysfunction, Prune–Belly syndrome), solitary or bilateral kidneys, and those without information in the electronic medical records regarding the diagnosis and surgery.

Pyeloplasty was indicated in patients with UPJO-like hydronephrosis with worsening hydronephrosis or renal function. This was assessed by the APD, the SFU classification, and the differential renal function value on static scintigraphy (reduction greater than 10% or an initial renal function of less than 40% with an obstructive pattern). Symptomatic patients with pain, infection, or calculi were also operated on.

The data collected were age, sex, diagnosis (radiological findings, prenatal hydronephrosis, pain, hematuria, urinary tract infection), laterality of UPJ obstruction, intraoperative findings (intrinsic UPJ stenosis, adhesions between the pelvis and ureter, high ureteral implantation, anomalous vessel), and ultrasound data (anteroposterior diameter APD, Society for Fetal Urology SFU grade, renal length). Each patient had the PPS calculated as stipulated in the original article.[4]

The anteroposterior diameter (APD) was obtained as the distance between the parenchymal boundaries at the renal hilum in a transverse view of the kidney. If there was both extrarenal and intrarenal APD, the larger value was used.[4]

The description of the results included the mean, standard deviation, median, minimum, and maximum values, absolute frequency, and percentage. Furthermore, the analysis involved the affected kidneys and the contralateral kidneys. Student's t-test was used for independent samples. Values of $p<0.05$ indicated statistical significance. The data were analyzed via IBM SPSS Statistics version 28.0.0.

Results

The list of pyeloplasties between July 1, 2012, and December 31, 2022, comprises 575 pyeloplasties. Of these, 120 patients fulfilled the inclusion criteria.

The mean age was 3 years and 9 months, with the majority of the patients being boys (67.5%) (Table 1). The left kidney was the most affected (68.3%). Approximately 49% (n = 30 of 61) had a prenatal diagnosis of hydronephrosis. The surgical description revealed intrinsic

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UPJO in 89.7% (n = 104 of 116) of the patients. Only 26 patients had scintigraphy data, and the mean relative function of the DMSA was 43.7% (Table 2).

The mean APD observed was 27.9 ± 15.1 mm. The contralateral to the operated kidney was 13.7 mm smaller than the affected kidney (83.7 mm vs. 71.2 mm, p<0.001) (Tables 2 and 3). The non-operated right kidney had a mean length of 73 mm, whereas the left kidney had a mean length of 70.4 mm (Table 4).

PPS variables (Table 5)

The patients were classified by SFU as grades I, II, III, and IV in 8.3%, 12.5%, 23.3%, and 55.8%, respectively. The APD was greater than 15 mm in 77.3% of the samples. The difference in length between the kidneys of the same individual was greater than 15% in 44.2% of the cases. The PPS calculation was equal to or above eight in 69.1% of the cases, with a mean PPS of 8.7 (median, 9; range, 1-12).

Considering patients aged up to one year, the PPS was equal to or above eight in 69.6% of patients (n = 32 of 46). In patients older than one year, the PPS was equal to or above eight in 68.9% (n = 51 of 74) of the patients.

Discussion

UPJO is more prevalent in boys and usually affects the left side.[4,5,6] A higher frequency was observed on the left (68.3%) and in males (67.5%). These characteristics were not correlated with PPS greater than or equal to eight. These factors have not been reported in other studies and therefore do not appear to influence the PPS value for surgical indications.[7,8]

With respect to diagnosis, 49% of patients already had hydronephrosis in the fetal period. Hydronephrosis may present in two ranges: patients with antenatal and postnatal diagnoses, who have different profiles.[8] However, the frequency of PPS greater than or equal to eight was similar in the patients above and up to one year old (68.9% vs. 69.6%). Although anomalous vessels, polyps, adhesions, and other factors can cause obstructive hydronephrosis, intrinsic stenosis was the main finding in this case series. As a consequence, it was not possible to determine differences in the PPS regarding the etiological factor due to the low frequency of other isolated causes.

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Renal Length

This increase in length is known to be associated with loss of renal function and high APD.[5] The obstructed kidney was, on average, one centimeter larger (83.7±23.5 mm vs. 71.2±20.6 mm, p<0.001). In general, the worse the degree of hydronephrosis is, the greater the renal length.[5] Other authors noted that the operated kidneys were 10.5 mm longer.[5] Additionally, the difference in renal longitudinal length (RLL) of ten millimeters when the affected kidney is on the left and six millimeters when it is on the right is significant, particularly with respect to the high likelihood of scintigraphic alteration, with predictive values of 79% and 100%, respectively.[6]

PPS Assessment

In response to the publication of the original article disseminated to the PPS in 2020, several authors presented important statements.[11] First, the SFU classification varies among different radiologists in clinical practice, and the APD is a variable measurement influenced by several factors, such as the degree of hydration, operator, breathing, bladder filling, and the patient's supine or prone position.[11]

The APD tends to be high in patients with extrarenal pelvis without cortical changes, so their PPS could be a false positive.[11] In practice, independent of the score, if the DPA is not obstructive and the patient is asymptomatic, some cases are managed conservatively.

Third, the C value, which estimates the difference in renal longitudinal length, limits the application of the PPS to patients with isolated and unilateral UPJ stenosis, as other conditions may interfere with the contralateral renal length.[11] Likewise, depending on the laterality of the disease, the percentage will already be constitutionally higher.[5, 6, 11] In this study, the C value of patients with right-sided UPJ obstruction was underestimated.[11] When the study sample was stratified by the C value, only 58.4% of the subjects scored two to four. This may have impacted 30% of the samples with PPS lower than eight. Taking into account the relevance of the difference in renal length of the affected kidney in reflecting loss of function,[5] the C value could be revised and considered a score of two, with values ranging from 10-15% instead of 11-15%.

The factors known as sonographic markers of established renal injury are renal cortical thinning, the presence of cortical cysts, parenchymal hyperechogenicity, reduced renal pyramid

thickness, and loss of corticomedullary differentiation.[12, 13, 14, 15] These factors are not part of the PPS. Moreover, the inclusion of these qualitative factors in a system for screening may compromise its reproducibility. On the other hand, the SFU classification superficially covers these morphological changes secondary to obstruction. Furthermore, with adequate training, it is possible to apply the PPS in daily practice, as the use of ultrasound in physical examinations is increasingly recognized.

The need for routine scintigraphy during follow-up or in newborn patients with renal immaturity as an alternative to other classifications already developed, such as the HSS, is a disadvantage. In practice, patients with mild hydronephrosis and SFU grades of 0 and 1 do not have a precise indication for scintigraphy. According to the PPS, this group of patients has a low score and, consequently, a low risk of progression to pyeloplasty, and they do not receive radiation.

Another classification for patients with congenital hydronephrosis is the UTD classification.[16] This is a more subjective and complex classification and is operator-dependent. Additionally, it does not require the SFU classification, which is one of the most widely used classifications in publications and is well established, having been in existence since 1993.[17] Unlike the UTD, the PPS uses both SFU and APD, as well as renal length. Furthermore, the UTD classification encompasses other diseases, including ureteral disorders, not just hydronephrosis due to UPJO.

Artificial intelligence (AI) is being used, with the prospect of improving healthcare, particularly in the field of diagnostic medicine. With this resource, it is possible to minimize the bias of the ultrasound examiner and optimize the use of classifications. A study using AI in the HSS classification of patients with antenatal hydronephrosis concluded that 50% of patients classified by AI as non-obstructed would undergo a renogram unnecessarily when the first ultrasound is evaluated.[18] There are no studies on the application of AI in PPS. The integration of AI learning systems into ultrasound systems may accelerate the triage of patients with a PPS above 8 by facilitating urgent referrals to centers specializing in treating hydronephrosis due to UPJ obstruction.

The PPS assessment of the control group revealed no significant changes. In 77.3% of the patients who underwent surgery, the APD was greater than 15 mm. This measurement is one of the main factors considered for the usual indication of pyeloplasty, as well as its increase.[9,10] In a prospective study of patients who received an antenatal diagnosis of

hydronephrosis, the cutoff points of antenatal APD of 18 mm and postnatal APD of 16 mm were associated with the need for pyeloplasty.[17]

Hydronephrosis was grade III or IV in 79.1% of the patients. The SFU classification was performed by the author via images associated with the radiologist's description, as the reports do not commonly include the SFU grade. Considering the subjectivity of classification and the dependence on the ultrasound windows performed and saved in the electronic system, the value found for severe hydronephrosis (grades III and IV) may be compromised and may not accurately represent the sample. Moreover, this is an example of the lack of standardization in examinations regarding the classification of hydronephrosis. There are several standardized systems for radiological classification by ultrasound, with SFU being the most commonly used in publications.[19] Adequate training and the presence of information in reports are essential for the application of tools such as PPS.

The ROC curve of the PPS corresponded to a sensitivity of 78% and a specificity of 90%.[4] In the sample of patients who underwent surgery, approximately 60% achieved a score of 8 or higher. In most cases, the isolated value of APD and the SFU classification likely guided the surgical indication. However, without scintigraphy data, it is difficult to infer the surgical indication in patients with PPS <8. It was not possible to establish a pattern in patients with PPS <8 operated on, whether surgeon dependent, owing to a clinical condition, etiology, or ultrasound worsening. This limitation arose because the study was retrospective and relied on information contained in medical records. There are no reports about this comparison in the literature.

Conclusion

The PPS is a tool for determining early surgical indications for patients with UPJO-like hydronephrosis when the score is equal to or greater than eight. In the survey, the mean PPS of the sample of 120 operated patients was 8.7. There was no difference related to sex, laterality, or etiology if the PPS was greater than or less than 8. The use of the ultrasound score would be sufficient for almost 70% of patients to indicate pyeloplasty without any other complementary exams. On the basis of this study, it is not possible to state that the PPS, without kidney scintigraphy, is effective in indicating pyeloplasty for every patient. However, it could be an excellent screening method. Prospective studies in various populations are necessary to

evaluate the PPS tool more accurately. The implementation of artificial intelligence could facilitate and objectify the dissemination of the method.

Tables

Table 1: Characterization of surgical patients (qualitative variables)

Variable	Classification	N	%
Laterality	Right	38	31.7%
	Left	82	68.3%
Diagnosis	Prenatal diagnosis	30	49.2%
(n=61)	Investigation of abdominal pain	16	26.2%
(59 unreported	Investigation of recurrent UTI	9	14.8%
cases)	Examination finding	5	8.2%
	Investigation of hematuria	1	1.6%
Etiology	Intrinsic UPJ stenosis	104	89.7%
(n=116)	Obstruction by anomalous vessel	6	5.2%
(4 unreported	UPJ stenosis and anomalous vessel	4	3.4%
cases)	Extrinsic obstructive adhesions to the UPJ	1	0.9%
	High ureteral implantation in the renal pelvis	1	0.9%

Legend: N = number; UTI = urinary tract infection; UPJ = ureteropelvic junction.

Table 2: Quantitative assessment of the samples.

Variable	N	Mean ± standard deviation	Median (minimum; maximum)
Age (months)	120	45.9 ± 51.5	22.5 (2; 201)
DMSA of the affected kidney (%)	26	43.7 ± 9.6	46.5 (17; 58)
APD (mm)	119	27.9 ± 15.1	25 (4; 81)
Difference in length of kidneys (%)	120	13.7 ± 15.1	13 (-62.2; 43.4)

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Legend: APD = anteroposterior diameter; DMSA = scintigraphy with dimercaptosuccinic acid; N = number.

Table 3: Length comparison.

Kidney	N	Mean Length (mm)	Standard deviation	Median (minimum; maximum)	p*
Affected	120	83.7	± 23.5	83 (28; 150)	<0.001
Contralateral	120	71.2	± 20.6	65.8 (26; 126)	

Legend: mm = millimeter; N = number.

*Student's t test, p<0,05

Table 4: Length of the renal units.

Length (mm)	N	Mean ± standard deviation	Median (min–-max)
Left Kidney (health)	38	73.0 ± 20.4	64 (43; 126)
Right Kidney (health)	82	70.4 ± 20.7	68 (26; 118)
Difference (RK - LK)	38	9.3 ± 15.7	8.5 (-28; 49)
Difference (LK - RK)	82	14.0 ± 11.8	12 (-8; 45)

Legend: mm = millimeter; N = number; RK = right kidney; LK = left kidney.

*Student's t test, p<0,05

Table 3: PPS variable distributions

Variable	Classification	Frequency	
		N	%
SFU	Normal	0	0
	1	10	8.30%
	2	15	12.50%
	3	28	23.30%
	4	67	55.80%
APD	<5 mm	3	2.50%
	5-10 mm	7	5.90%

	11-15 mm	17	14.30%
	16-19 mm	14	11.80%
	≥20 mm	78	65.50%
C value	<5%	27	22.50%
	5-10%	23	19.20%
	11-15%	17	14.20%
	16-19%	9	7.50%
	≥20%	44	36.70%

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