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Research Article

Assessing the Predictive Ability of the Pyeloplasty Prediction Score on Surgical Outcomes: A New Use of a Tool in Pediatric Urology

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Abstract: Background: Pediatric urology requires precise surgical techniques and effective communication with parents. Establishing trust through knowledge sharing is essential for guiding treatment pathways. Parents, particularly those with antenatal diagnoses, seek reassurance through counseling. Antenatal hydronephrosis, affecting approximately 1 in 1000-1500 live births, often involves conditions like Pelviureteric junction obstruction (PUJO). Various scoring systems, including the ultrasound-based Pyeloplasty Prediction Score, assist in predicting surgical outcomes. Leveraging such scores as counseling tools enhances parental understanding and facilitates informed decision-making in pediatric urology.

Objective: To evaluate the predictive ability of Pyeloplasty Prediction Score on surgical outcomes of Pyeloplasty and to assess the use of this score as a counselling tool.

Materials and Methods: This prospective study, conducted at the Department of Urology, Tabba Kidney Institute, enrolled 50 patients under 15 years with antenatal hydronephrosis or incidental diagnosis of HDN. Patients over 15 years of age and those with bilateral hydronephrosis were excluded. The Pyeloplasty Prediction Score, comprising SFU grade, Anteroposterior Pelvic Diameter (APPD), and percentage renal length difference, was used for risk stratification. Scores were categorized as low (≤4), intermediate (5-7), or high (≥8) risk. Post-pyeloplasty, patients were monitored for hydronephrosis resolution and cortical thickness gain via ultrasound. Resolution was defined as APPD less than 10mm or more than 50% decrease from preoperative value.

Result: Out of the enrolled 50 patients, with a mean age of 6 years (range: 2 months to 11 years), 28 (56%) were female and 22 (44%) were male. 56% presented with antenatal hydronephrosis, while 44% had incidental PUJO-like HDN. 20 patients (40%) were categorized as high risk, and 30 patients (60%) as intermediate, with none in the low-risk group. Laparoscopic Retroperitoneal Pyeloplasty was performed in 19 patients (38%) above 2 years, and open Pyeloplasty with DJ stenting in 31 patients (62%) below 2 years. Postoperatively, 24 patients (80%) in the intermediate-risk group showed cortical thickness gain, compared to 9 patients (45%) in the high-risk group (p=0.05). Resolution of hydronephrosis was observed in 13 patients (65%) in the high-risk group and 12 patients (40%) in the intermediate-risk group, possibly due to pelvis excision in severely hydronephrotic cases (p=0.78).

Conclusion: The Pyeloplasty Prediction Score serves as an effective counseling tool for predicting the outcome of Pyeloplasty in terms of cortical gain, eliminating the need for radioisotope exposure post operatively. However, its effectiveness in predicting hydronephrosis resolution is limited.

Keywords: Pyeloplasty Prédiction Score, Anteroposterior Pelvic Diameter, Hydronephrosis, Pelviureteric junction obstruction, Patient.

INTRODUCTION

Pediatric urology encompasses the intricate surgical handling of tiny tissues along with the most difficult of the reconstruction. Dealing with the patients' parents is indeed the most challenging aspect of this field [1]. The foundation of a surgeon's relationship with the parents is built on trust and sharing of knowledge and that further guides the streamlined direction of the treatment.

The worried parents especially the ones with antenatal diagnosis consult with high hopes and counselling serves as the essential part of this relationship building. Along with words, surgeons have to be careful and honest in their word selection, and quoting facts and figures along with diagrammatical explanation imparts a better understanding on the parents rather than words alone [2, 3].

Antenatal Hydronephrosis is one of the most challenging aspects with a wide spectrum of diagnosis. It could be unilateral or bilateral with a major bulk of patients (1 in 1000-1500 live births) being Pelviureteric junction obstruction (PUJO) or PUJO like hydronephrosis [4]. There have been multiple parameters and scoring systems for predicting the outcome and need of surgical management of PUJO-like HDN. Some scores use diuretic renogram and patients' own parameters to assess and predict the success outcomes.

One score called the Pyeloplasty Prediction Score has been developed [5] and is being used for the prediction of need of surgery in PUJO like HDN. It could be a very effective and eco-

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nomical tool in a developing country like ours as it is totally an ultrasound based scoring system and we hypothesized to use it to understand the outcome of surgery to make use of it as a counseling tool. The Original score has three components giving importance to SFU grading of hydronephrosis, Anteroposterior Pelvic Diameter (APPD) and percentage difference in both renal lengths, hence combining both collecting and functioning aspects of a renal unit to collectively form a score that can stratify the patient into high, intermediate or low risk categories, with risks pertaining to the likelihood that the child will need surgery for PUJO.

Detailed counselling can then further help in creating an informed guideline of the treatment. Gold standard surgical treatment of PUJO is Laparoscopic [6] or open [7] or Robotic [8] dismembered (Anderson-Hynes [9]) Pyeloplasty over a DJ stent, or otherwise, it can be treated via different techniques of Pyeloplasty or endoscopically with endopyelotomy. Resolving hydronephrosis with decreasing APPD and not impairing the renal function can be dealt conservatively. Guidelines recommend intervening at split renal function below 40% [10]. Vascular anomalies causing PUJO are also dealt with in different manner if needed [11].

The aim of our study is to use a pre-existing scoring system that is used to predict surgical need in terms of predicting surgical outcomes of Pyeloplasty.

MATERIALS AND METHODS

It is an experimental study conducted at the Department of Urology, Tabba Kidney Institute and sample size was calculated with the help on WHO sample size calculator, keeping total procedure performed in previous 6 months of study as population (n=57), Confidence level as 95% and margin of error as 5% the estimated minimum required sample size as 50 patients. The study was approved by the hospital ethics review committee with an IRB number of TKI-HEC 31, from the time period of November, 2023 till March 2024. Patients included were less than 15 years of age presenting with diagnosis of antenatal hydronephrosis or incidental finding of hydronephrosis. Patients above 15 years and those with bilateral hydronephrosis were excluded from the study. Pre-operatively, children were evaluated on first visit with ultrasound and the Pyeloplasty Prediction Score was calculated. The score comprised of three components and each component was scored from 0 to 4. Patients were then divided into low, intermediate and high risk groups. The original risk stratification was to predict the need of surgery in patients with PUJO-like HDN. We have used this scoring system and risk stratification to predict the outcome of pyeloplasty, when needed, in the patients, on the basis of scoring (Fig. **1**) [5].

The score was calculated as follows; the first component was SFU grading of hydronephrosis and the score corresponded to the SFU grade, with 0 points for no HDN and 1 point for SFU grade 1 and so on. This was the component A of the score.

A.	**SFU grading of affected kidney on ultrasound**
0	Normal
1	SFU Grade 1
2	SFU Grade 2
3	SFU Grade 3
4	SFU Grade 4
B.	**APD measurement of affected kidney on ultrasound**
0	<5 mm
1	5–10 mm
2	11–15 mm
3	16–19 mm
4	≥20 mm
C.	**Absolute percentage difference between the ipsilateral and contralateral renal lengths][100% * (Ipsilateral Renal Length- Contralateral Renal Length)/Ipsilateral Renal Length]]**
0	<5%
1	5%–10%
2	11%–15%
3	16%–19%
4	≥20%
PPS = A + B + C	

Each parameter is assigned a score from 0 to 4, 0 being least severe and 4 being most.

Fig (1). Original Scoring System [5].

Component B was for the Anteroposterior Pelvic Diameter (APPD), with 0 points for less than 5mm APPD, 1 point for 5 to 10 mm, 2 points for 11 to 15 mm, 3 points for 16 to 20 mm and 4 points for more than 20 mm. It was measured in transverse view of ultrasound and taken as the distance between both parenchymal lips.

Component C was for absolute percentage difference of renal lengths between the ipsilateral and contralateral kidneys. It was measured in longitudinal view of ultrasound and was defined maximum distance between both the upper and lower poles. The difference between ipsilateral renal length and contralateral renal length was divided by the ipsilateral renal length and multiplied by 100 to obtain this value. 0 points were reserved for a value less than 5 % while 1 point was for a value of 5 -10%, 2 points were for a value 11-15%, 3 points for 16-20% and 4 points for a difference of more than 20%.

The formula is written as follows:

$$\text{Percentage Difference} = 100 \times \frac{\text{Ipsilateral Renal Length} - \text{Contralateral Renal Length}}{\text{Ipsilateral Renal Length}}$$

Total cumulative score was calculated by adding the score of all components that is A+B+C. score less than or equal to 4 were deemed low risk, scores from 5 to 7 were intermediate risk, and scores above and equal to 8 were high risk (Table **1**).

Table 1. Risk Stratification according to Scores.

Risk Groups	
Score	**Group**
≤4	Low
5-7	Intermediate
≥8	High

Originally, the risk stratification was to predict the need of surgery in patients but we have applied the stratification to predict the outcome of surgery in terms of resolution of hydronephrosis and cortical gain.

The patients who underwent Pyeloplasty were then postoperatively observed for resolution of hydronephrosis and gain in cortical thickness on ultrasound after 3 months post procedure. Resolution of hydronephrosis was defined as APPD less than 10 mm or a decrease in APPD less than 50% of the preoperative value.

STATISTICAL ANALYSIS

Statistical package for social sciences (SPSS) version 22 was used to enter, sort and analyze the data. For continuous variables like age, APPD and cortical thickness mean and standard deviation was measured, categorical variables were analyzed in frequencies and percentages. To assess the difference between two categorical values chi-square's tests was performed, p-value of < 0.05 was considered as significant. An independent samples t-test was applied to observe the differences in risk stratification and the pre-and post-operative cortical thickness of APPD and SFU grading separately.

RESULT

The 50 patients were enrolled in the study. Mean age of the patients was 6 years with an age range from 2 months to 11 years. 22 (44%) were male while 28 (56%) were female. 28 (56%) patients presented with the diagnosis of antenatal hydronephrosis while rest of 22 (44%) patients presented with incidental diagnosis of PUJO-like HDN on ultrasound. 20 patients (40%) were found to be in high risk category while rest 30 (60%) were found to be in intermediate category. None of the patients fell in the low risk category. 19 (38%) patients were above 2 years of age and underwent Laparoscopic Retroperitoneal Pyeloplasty while rest of the 31 (62%) patients were below 2 years and they underwent open Pyeloplasty and DJ stenting.

Patients were followed post operatively with the help of ultrasound and gain in cortical thickness and resolution of HDN was noted. Among the intermediate risk group, 24 (80%) patients showed a gain in cortical thickness at 3rd month post op ultrasound while rest 6 (20%) showed no gain. If we look at the high risk group, 9 (45%) patients showed gain in cortical thickness while 11 patients (55%) showed no gain (P-value: 0.05) (Table **2**).

Table 2. Cortical Gain in Both Risk Groups.

Cortical Thickness	Intermediate Risk	High Risk
Gain	80% (24)	46% (9)
No gain	20% (6)	54% (11)

Upon observing the resolution of hydronephrosis, 13 patients (65%) of the high risk group patients showed resolution while this number reduced to 12 (40%) of the intermediate risk group members. This result can be explained by the excision of redundant pelvis in grossly hydronephrotic system (p- value: 0.78).

Independent samples t test was used to assess difference between the means of score prediction for pyeloplasty success rate, 95% confidence interval for mean value was determined between 5-7 intermediate risk and >8 high risk categories with pre-operative and post-operative value of APPD, SFU and Cortical thickness results, results indicated significant difference in pre and post value of APPD with 0.611-1.589 and 0.624-1.169 (Lower - upper) for intermediate and high risk group respectively, with p-value of 0.412. SFU grading indicated 2.04-2.85 and 1.72-2.42 (lower-upper) in intermediate and high risk categories respectively (P-Value 0.852). Similarly the post-operative cortical thickens was measured as 0.485-0.803 and 0.656-0.773 (lower 0 upper) in intermediate and high risk respectively (p-value 0.047). Only significant p-value was reported in Post procedure cortical thickness values with 0.047, while all other p-values were insignificant (Table **3**).

Table 3. Statistical Analysis.

Variables		Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		P-Value
					Lower Bound	Upper Bound	
Post APPD	5-7 INTER	1.100	.6364	.2121	.611	1.589	0.412
	>8 HIGH	.896	.7021	.1327	.624	1.169	
Post SFU	5-7 INTER	2.44	.527	.176	2.04	2.85	0.852
	>8 HIGH	2.07	.900	.170	1.72	2.42	
Post CT	5-7 INTER	.644	.2068	.0689	.485	.803	0.047
	>8 HIGH	.714	.1508	.0285	.656	.773	
Pre APPD	5-7 INTER	2.0000	1.19583	.39861	1.0808	2.9192	0.968
	>8 HIGH	2.8250	1.11874	.21142	2.3912	3.2588	
Pre SFU	5-7 INTER	2.89	.333	.111	2.63	3.15	0.997
	>8 HIGH	3.19	.934	.176	2.83	3.55	
Pre CT	5-7 INTER	.644	.2068	.0689	.485	.803	0.674
	>8 HIGH	.714	.1508	.0285	.656	.773	

DISCUSSION

As per our results, the Pyeloplasty Prediction Score is easily reproduce and has been innovatively used as a counselling tool and also as a surgery figure predictor. The ease of using the score is based on the fact that it uses sole ultrasound and its parameters to give a quick overview of the child's renal status and the predictive outcome of the surgery in terms of objective parameters like gain of cortex. The original score does state the obvious limitations of being operator dependent [12]. Retrospectively, as none of our patients that underwent surgery, fell into the low risk category, this fact further validates the score and its ability to predict the need of surgery. The patients that were placed in the High risk group in the preoperative counselling session ended up having least improvement in the cortical gain as predicted while the Intermediate group had better outcome in this parameter. In the context of hydronephrosis resolution, the high risk group had slight edge over the intermediate group and our explanation for this may be the reason that more obstructed kidneys with severely dilated pelvicalyceal systems respond more in terms of resolution of hydronephrosis when they are relieved of their obstruction along with excision of redundant pelvis as compared to the less dilated intermediate group.

The commentary on the score by Onen AR, subjects this score to the already established limitations and the fact that bilaterally of the disease or compensatory hypertrophy can affect the C component of the score and further indicate false severity of the disease [13]. A newer scoring system called Onen Hydronephrosis Score is also proposed with more defined objectivity but it does not include AP diameter which has been a mainstay in diagnosis of antenatal and PUJO- like HDN. It is composed of pelvic and calyceal dilatation and condition of the cortex. This score does have the potential to be reproduced but does not seem a quick option to use in the clinic [14].

Other scoring systems such as MAG-SOS score uses differential renal function, renogram curve,T1/2 and ultrasound parameters combined as parameters to assess the need of Pyeloplasty and the authors used this score retrospectively to conclude that the DRF was the independent prognostic factor in predicting the need of Pyeloplasty and a score of 5 showed 100% specificity for obstruction. 78% of the renal units requiring surgical intervention had a score above or equal to 5. The score does provide a fresh and objective insight in the predictive model race but requires a renogram that disregards its use in outpatient use on first visit and also exposes the child to radioisotopes [15, 16].

Similarly, Hydronephrosis Severity Score by Babu *et al*, also includes both ultrasound and renogram values. It does not include T1/2 in its parameters but further tries to objectify the predictive ability of the score by incorporating the split function and curve type in the score. Again, PPS is easier, ultrasound based and quicker to use in our area of interest [17, 18].

Other ultrasound based parameter, the renal pyramidal thickness has also been used to predict the need of surgery but it can only be used in SFU 3 and 4 and disregards the lower grades of HDN as it is difficult to assess the pyramidal thickness on ultrasound with lower grades of dilatation. This only includes one parameter and is very limited and subjective [19, 20].

There are other nomograms and models as well but, we would like to mention the predictive nomogram for Laparoscopic Pyeloplasty this is one score that, like us, can be used to counsel for the outcome of surgery but it is only limited to Laparoscopic Pyeloplasty and also is heavily dependent on patient parameters such as weight. It also includes the per-operative difficulty during the surgery, hence, it cannot be used in the clinic pre operatively but rather an important tool to explain the outcome to the parents post operatively [21, 22]

Another parameter is under discussion called the calyceal-to-parenchymal ratio measured on post natal ultrasound. It is also used as a potential predictor of surgery, but it has only been utilized in newborns with grade 3 and 4 hydronephrosis [23, 24].

A comparative study examined pediatric patients who underwent open pyeloplasty, focusing on the percentage of pelvic improvement (PI) in the anteroposterior diameter (APD) as a predictive marker for surgical success. The analysis revealed that a PI in APD exceeding 26% at 6 months post-surgery strongly correlates with a successful outcome, thus obviating the necessity for repeated nuclear scans [25].

The point of discussion to be highlighted is the fact that none of these scores are standardized and can be reproduced and amended as per the surgical expertise and need of the hour, but a multicenter, comparative analysis should be conducted to provide more objectivity to these scoring systems and their uses. Avoidance of diuretic renogram before building a trustworthy relationship with the parents through objective counselling, can be an important pro of aforementioned scoring system.

CONCLUSION

Pyeloplasty Prediction score is an effective score that can used as a counselling tool to predict the outcome of Pyeloplasty in terms of gain in cortex, without the need of radioisotope exposure. It does not predict resolution of hydronephrosis effectively.

LIMITATION

It is a single center study. Very limited number of patients were enrolled in the study and this score was assessed for counselling purpose. The patients were followed for a short duration.

The score and the results can be further validated and analyzed with larger number of subjects, longer follow-up duration and with multiple centers involved for the benefit of pediatric population and their parents.

AUTHORS' CONTRIBUTION

- **Umber Rasheed**: Conception and design of study, Manuscript writing.

- **Sherjeel Saulat**: Critical revision.
- **Ashba Mushtaque**: Data analysis.
- **Muhammad Osama**: Data entry.
- **Anil Kumar Utraadi**: Data collection.
- **Jahanzeb Shaikh**: Detailing of manuscript.

CONFLICT OF INTEREST

Declared none.

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