Original Article

Predictive Value of the Postural Difference in Antero-Posterior Diameter of Renal Pelvis on Ultrasonography of Unilateral Ureteropelvic Junction Obstruction in Determining the Need For Surgery

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Abstract

Background: Ureteropelvic junction obstruction (UPJO) is the most common cause of antenatal hydronephrosis. Although majority of them improve with time, none of the existing diagnostic modalities can accurately predict which hydronephrotic kidney is at the risk of progressive renal damage and will benefit from early surgery. Postural variations in the anteroposterior pelvic diameter (APPD) of the hydronephrotic kidney in children during follow-up postnatal ultrasonography (USG) reflect the intrapelvic tension, which might help in predicting the need of surgery amongst these patients. **Materials and Methods:** We designed this prospective observational study in all unilateral UPJO patients on postural variation in the APPD of renal pelvis on ultrasonography. The mean age of all patients were 2.15 years (0-5 years) and managed at our institute at All India Institute of Medical Sciences, Bhubaneswar. The study duration was from July 2019 to May 2021. The management of these patients was done as per the standard institutional protocol and there was no deviation due to inclusion in this study. We documented the variations in postural APPD both amongst the conservatively managed group and the surgically managed group of patients. Linear correlation between two continuous variables was explored using Pearson's correlation (if the data were normally distributed) and Spearman's correlation (for non-normally distributed data). **Results:** We found a higher prone APPD than supine APPD in all these patients indicating the obstruction at ureteropelvic junction. However, in the surgical group, there was less variation in the postural APPD compared to the conservative group, and when there was no variation in the postural APPD, the need of surgery was 100%. The limitation of our study was the small sample size (n = 36). A study involving a larger population or involving multiple institutions may further add significance to our findings. **Conclusion:** We found less postural variation in APPD on USG to be more likely associated with severe UPJO requiring early surgery. This may indicate a non-compliant renal pelvis. However, it was statistically not significant.

Keywords: Anteroposterior pelvic diameter, hydronephrosis, pyeloplasty, ultrasound, ureteropelvic junction obstruction

Introduction

Ureteropelvic junction (UPJ) is a common site of dysfunctional drainage within the urinary tract. UPJ obstruction (UPJO) is the most common anatomical cause of foetal antenatal hydronephrosis. A majority of cases with hydronephrosis will not require any surgical intervention and may be managed expectantly. The Society for Fetal Urology (SFU) formulated a consensus statement in an attempt to standardise follow-up with a specific emphasis on increasing the efficiency of testing without undue risk.[1] Although it is easy to diagnose hydronephrosis, it is unfortunately difficult to predict any physiologically significant obstruction that might require surgical correction. None of the existing diagnostic modalities can accurately predict which hydronephrotic kidney is at risk of progressive damage and subsequent loss of renal function.[2] The need for surgical intervention hangs like

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a sword of Damocles on the baby, and the parents and the clinician are faced with a 'Hamletian' dilemma, whether to intervene surgically or not.[3]

There are several studies available in literature depicting the role of the anteroposterior pelvic diameter (APPD) of the affected kidney on ultrasonography (USG) in predicting the need for surgical intervention amongst these patients. It is important to highlight that the interpretation of APPD in renal USG is dynamic. Several additional factors should be considered, such as the degree of bladder filling, comparison to previous ultrasound measurements, overall SFU grade of dilatation and overall tension in the system. This last element is rarely addressed in the literature but has a significant role in the decision to intervene surgically.[4]

Prone positioning enhances the drainage of the renal pelvis and the collecting system and urine empties rapidly into the ureters due to better alignment across the UPJ.[5] Thus, the non-obstructive dilated pelvis would drain better in the prone position and would have an APPD smaller than that in the supine position. Sharma *et al*. have documented that the APPD decreases when measured in the prone position.[6] The role of a postural difference in the APPD on USG in predicting the need of surgical intervention in patients with UPJO is being discussed by few experts in the field. USG done in the prone and supine positions can help differentiate non-obstructive dilatation from obstructive dilatation. While a non-obstructive dilated pelvis can drain better in the prone position, obstructive systems cannot. On the other hand, the obstructed systems would not drain better in prone position, and hence, the anteroposterior diameter (APD) of these systems, in prone position, would be more or equal to the APD in supine position.[7]

In this study, we prospectively evaluated the predictive value of a postural difference in the APPD on USG impacting the need of surgery in patients of UPJO. This may help in improving surgical management strategy, thus avoiding unnecessary surgery for reversible cases and on the other hand offering early surgery before renal deterioration in pathological cases. It may also categorise patients into those requiring close surveillance and those who do not need frequent monitoring.

Materials And Methods

This is prospective observational study. The mean age of all patients were 2.15 years (0-5 years) with unilateral hydronephrosis due to UPJO. The study was conducted at our institute at All India Institute of Medical Sciences, Bhubaneswar from July 2019 to May 2021. This study was a part of a thesis project for M. Ch. Training programme conducted with the approval of the Institute Ethics Committee (IEC/AIIMS BBSR/PG Thesis/2019/20/71) and was enrolled in the Clinical Trial Registry of India (REF/2020/04/033245[DE]). All patients were managed as per the standard protocol of treatment of the department and there was no deviation in managing these patients for being included in this study. All patients were evaluated with routine blood investigations, renal function tests, ultrasound KUB and 99mTc-EC scan at initial presentation and were followed up serially at regular intervals and managed either conservatively or surgically as the situation demands.

Children underwent ultrasound evaluation after proper hydration and voiding and the data were collected on bilateral renal bipolar length, cortical thickness, APPD both in supine and prone position, ureteric diameter (if dilated), bladder wall thickness and post-void residual urine. The children were examined after they had voided because a full bladder can affect the APPD measurement and impair drainage of urine from the kidney into the bladder. The APPD was measured at the level of renal hilum in the transverse plane in supine position and then the child was made prone and APPD was re-measured at the level of renal hilum in the transverse plane [Figure 1]. USG KUB was performed with LOGIQ S8 machine by the same sonologist (MD Radiology, Associate Professor) to avoid any operator bias. Convex probe of frequency 5–8 MHz was used for renal assessment of the children during the study.

The patients were managed either conservatively or by surgery, which was decided according to the standard protocol followed in our institute based on clinical features, USG KUB parameters and diuretic renogram findings. The indication for surgery and the type of surgery (open and laparoscopic pyeloplasty) was done according to our pre-decided institutional protocol. Follow-ups were done at 3 months, 6 months and 1 year after enrolment in the study and after surgery in those who were managed surgically. Apart from detailed clinical examination; ultrasound KUB and 99 mTc-EC renogram were done during the post-operative follow-up.

The data were coded and recorded in MS Excel spreadsheet. SPSS version 23 (IBM Corp., Chicago) was used for data analysis. Descriptive statistics were elaborated in the form of means/standard deviations and medians/IQRs for

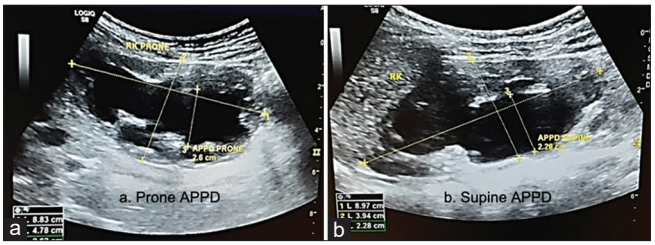


Figure 1: (a) Prone (b) Supine. APPD of right kidney of the same patient. APPD: Anteroposterior pelvic diameter

Table 1: Overall mean anteroposterior pelvic diameter in supine versus prone positions

	Mean±SD
APPD in supine (cm)	1.97±1.02
APPD in prone (cm)	2.43±0.98
Difference supine-prone	0.54±0.23

APPD: Anteroposterior pelvic diameter, SD: Standard deviation

Table 2: Group-wise mean anteroposterior pelvic diameter in supine versus prone positions

	Group, mean±SD		
	Conservative (n=15)	Surgical (n=21)	P
APD supine (cm)	1.33±0.48	2.43±1.07	<0.001
APD prone (cm)	1.79±0.30	2.89±0.98	<0.001
Postural difference in supine-prone APPD (cm)	0.56±0.20	0.52±0.26	0.602

APPD: Anteroposterior pelvic diameter, SD: Standard deviation, APD: Anteroposterior diameter

Table 3: Linear correlation between supine and prone anteroposterior pelvic diameter

	Pre-operative APPD supine (cm)	Pre-operative APPD prone (cm)
APPD supine in cm pre-operative		
Pearson correlation	1	0.921**
Significant (two-tailed)		0.000
n	36	36
APPD prone in cm pre-operative		
Pearson correlation	0.921**	1
Significant (two-tailed)	0.000	
n	36	36

**Correlation is significant at the 0.01 level (two-tailed). APPD: Anteroposterior pelvic diameter

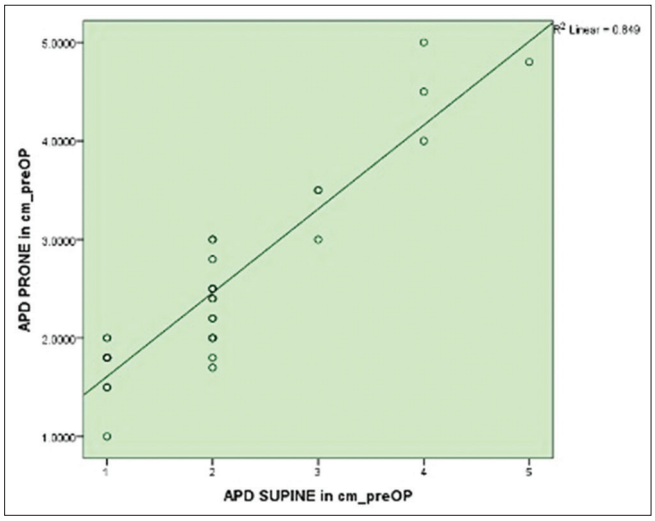


Figure 2: Scatter plot analysis, supine and prone APPD. APPD: Anteroposterior pelvic diameter

continuous variables and frequencies and percentages for categorical variables. The data were presented in a graphical manner wherever appropriate for data visualisation. Group comparisons for continuously distributed data were made using independent sample *t*-test when comparing two groups. If the data were found to be non-normally distributed, appropriate non-parametric tests in the form of Wilcoxon test were used. Chi-squared test was used for group comparisons for categorical data. In case the expected frequency in the contingency tables was found to be < 5 for > 25% of the cells, Fisher's exact test was used instead. Linear correlation between two continuous variables was explored using Pearson's correlation (if the data were normally distributed) and Spearman's correlation (for non-normally distributed data). Statistical significance was kept at $P < 0.05$.

Results

In this study, a total of 36 children with unilateral hydronephrosis due to UPJO were included. There were 28 boys and 8 girls. In our study, 23 children (63.9%) had UPJO on left side and 13 children (36.1%) had UPJO on right side. Amongst boys, left-sided disease was more prevalent in 67.85% of cases; whereas amongst girls, 50% had left-sided disease.

Out of total 36 children, 21 (58.3%) underwent surgery; and the rest 15 (41.7%) were managed conservatively. The criteria for selection of patients for surgery or conservative management were according to the standard protocol followed in our institute based on the clinical features, ultrasound parameters, function and drainage pattern on diuretic renogram.

The overall mean APPD in supine position was 1.97 cm and that in prone position was 2.43 cm with a mean difference of 0.54 cm [Table 1]. Amongst the conservative group, the mean APPD was 1.33 cm in supine position and 1.79 cm in prone position, and amongst the surgical group, the mean APPD was 2.43 cm in supine position and 2.89 cm in prone position [Table 2]. In both the groups, there was a statistically significant increase in APPD in prone position than that in the supine position ($P < 0.001$).

The mean difference between supine and prone APPD in the conservative group was 0.56 cm and that in the surgical group was 0.52 cm. We did not find any statistically significant difference between these two observations ($P = 0.602$). However, in the scatter plot analysis, both the supine and prone APPD appear to be significantly correlated. The correlation between prone and supine APPD is shown in Table 3 and Figure 2.

When the difference between supine and prone APPD is compared between surgical and conservative groups, it was found that variation is more in the APPD of patients in the conservative group. We categorised the result of the postural difference in APPD into 3 groups (difference of 0 mm, difference between 1 and 5 mm and difference between 6 and 10 mm). We found when there was no variation in the supine and prone APPD ($n = 1$), the requirement of surgery was 100%. In the group with 1–5 mm postural variation in APPD ($n = 16$),

Table 4: Categorisation of the postural variations in anteroposterior pelvic diameter versus need for surgery

Different categories (according to difference in supine and prone APD) (mm)	Intervention		Total	Children requiring surgery (%)	*P*
	Conservative (*n*=15)	Surgical (*n*=21)			
0	0	1	1	100	0.306
1–5	5	11	16	68.7	
6–10	10	9	19	47.3	
Total	15	21	36	58.3	

APD: Anteroposterior diameter

the requirement of surgery was 68.7%. The group with 6–10 mm variation between supine and prone APPD (n = 19) has requirement of surgery in 47.3% of cases. Ten patients in the conservative group had difference of more than 5 mm between supine and prone APPD (66.7%). In comparison, only nine patients in the surgical group (42.9%) had a difference of more than 5 mm. Similarly, smaller postural difference in the supine and prone APPD (5 mm or less) was observed in 57.1% of cases in the surgical group. However, this observation was not found to be statistically significant (P = 0.306). The comparison in difference between supine and prone APPD is shown in Table 4.

Discussion

Unilateral UPJO is the most common cause of obstructive uropathy and may lead to renal impairment and loss of renal function. In most cases, the aetiology of prenatal hydronephrosis is transient or physiological, has no clinical significance and is likely to resolve at the end of pregnancy or within the 1st year of life.[6] Although there are several publications supporting initial conservative treatment of Pelvic ureteric junction (PUJ) obstruction diagnosed prenatally, several authors have expressed concern about loss of renal function during expectant management.[8-10] McAleer and Kaplan opined that waiting for renal function to decrease before considering pyeloplasty is not warranted, since function does not improve even when obstruction is corrected and drainage time improves.[11] The dilemma then arises of how to differentiate clinically significant hydronephrosis from that which may resolve spontaneously.

Many factors have been suggested as predictors related to future deterioration of renal function. The main difficulty at this point of time is that none of the parameters measured by conventional tools including USG, diuretic renogram, magnetic resonance imaging, or even biochemical markers, has given us a reliable predictive value for selection of cases for surgery and prompt assessment of post-operative improvement.[12] Although the radionuclide renogram is a gold standard, the drainage curves from the initial renogram are not predictive of those requiring surgical intervention for UPJO.[6] The current diagnostic approach with renal imaging cannot reliably determine which newborns and infants <2 years of age have a significant obstruction and are at risk for permanent kidney damage.[13] The search is still on to identify a parameter that will be more reliable for predicting the need for surgery by reflecting functional deterioration of the affected kidney and prompt identification of factors signifying improvement during post-operative follow-up.

Sharma *et al*. have documented that USG done in the prone and supine positions can help differentiate non-obstructive dilatation from clinically significant obstructive dilatation.[6] In their study, they had concluded that those cases with prenatally detected UPJ type of hydronephrosis and an APPD smaller in the prone than in the supine position on postnatal evaluation show improvement in hydronephrosis on follow-up, whereas those cases in which there is no change in APPD in the supine and prone positions are at increased risk for damage. While a non-obstructive dilated pelvis can drain better in the prone position due to better alignment, the obstructive systems cannot. The higher prone APPD found in our study population suggests that the pathology was obstructive in nature.

The rationale for the smaller APPD in the prone position in cases which showed improvement and eventual resolution of hydronephrosis is easy to understand from the prone films taken during excretory urography. Prone positioning enhances the drainage of the renal pelvis and the collecting system empties rapidly in the ureters. The gravity-dependent drainage also gets affected in supine position (but this excluded in prone position). In the prone position, the lower pole of the kidney and the proximal end of the ureter are placed more anteriorly than the upper pole of the kidney. The pelvis also falls anterior to the psoas muscle. The pelvis and upper ureter fill more rapidly in prone position.[5] Thus, the non-obstructive dilated pelvis would drain better in the prone position and would have an APPD smaller than that in the supine position. However, obstructed systems would not drain better in the prone position and; thus, the APPD in the supine and prone positions in these systems would be similar.[6]

There are also other factors influencing the supine and prone APPD, apart from the obstruction of UPJO. The loaded colon presses on the renal pelvis and thus decreases the APPD in supine position unlike the prone position. This may result in a smaller supine APPD than the prone APPD in obstructed systems. However, in high grade obstruction, the tense pelvis may not be compressed by the loaded colon in supine position, thus resulting in insignificant postural difference in the APPD. An increase or no change in AAPD in prone position is associated with poor outcome.[5]

In our study, both the supine and prone APPD appear to be significantly correlated as found out from the scatter plot

analysis [Figure 2]; there was a sizable variation between the supine and prone APPD in the conservative group than the surgical group. Variations of more than 5 mm are more common in the conservative group (66.7%) in comparison to 42.9% in the surgical group. Smaller or no difference in the supine and prone APPD (5 mm or less) was commonly seen in the surgical group (57.1%) in comparison to 34.3% in the conservative group. This can be explained by considering the factors influencing the supine and prone APPD, apart from the intrapelvic tension due to severity of obstruction at UPJ. Only a very few literature available have discussed on this aspect.

In our study, the requirement of surgery was 100% when there is no postural difference in APPD, i.e. 0 mm (n = 1). This indicates high intrapelvic pressure in severe obstruction or a non-compliant pelvis. This requirement decreases to 68.7% when the difference in APPD is between 1to 5 mm (n = 16) and further decreases to 47.3% (n = 19) when the difference in APPD is between 6 and 10 mm. A multicentre study with a large sample size may further confirm our findings.

Conclusion

From our study, postural difference in APPD correlates well with the severity of the UPJO and requirement of surgery. We also found less postural variation in APPD on USG to be more likely associated with severe UPJO requiring early surgery. This may indicate a non-compliant renal pelvis. However, a larger and possibly multicentre study is required to validate this outcome.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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