Original Article

Comparison of two drainage parameters on diuretic renogram in predicting the fate of prenatally detected pelvi-ureteric junction-like obstruction

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ABSTRACT

Introduction: In infants with suspected pelviureteric junction (PUJ) like obstruction, we compared the drainage patterns suggested by t 1/2 and normalized residual activity (NORA) to determine which parameter can differentiate obstructive from nonobstructive dilatation and thus predict the need for surgery.

Materials and Methods: Infants presenting with prenatally detected PUJ-like obstruction from January 2014 to March 2020 were evaluated with ultrasonography. Diuretic renogram was performed using Tc99m ethylene dicysteine using the F0 protocol. Subjects with a differential renal function >40% were included in the study. The t ½ values were noted. NORA was calculated by dividing the tracer values at 60 min with the values at 2 min. The infants were followed using ultrasonography. Renogram was repeated if there was increase in hydronephrosis or after 6 months if hydronephrosis did not regress. The follow-up was continued till a decision for pyeloplasty was made or the hydronephrosis regressed. Pyeloplasty was advised if differential function dropped to below 40%.

Results: 34 patients met the inclusion criteria. NORA and t ½ had very poor concordance in defining the drainage pattern. t ½ values did not correlate with the need for surgery or conservative management ($P \geq 0.05$). Good drainage pattern by NORA was associated with regression of hydronephrosis ($P \leq 0.001$). NORA predicted obstruction more accurately.

Conclusion: NORA can define good drainage in a much larger subset of patients with PUJ-like obstruction who eventually do not need surgery. However, further multicenter studies are needed to confirm this.

INTRODUCTION

Pelviureteric junction (PUJ)-like obstruction is the most common abnormality seen in infants with prenatally detected hydronephrosis.[1] The dilemma that a clinician faces in the evaluation of these cases is to differentiate a dilated but nonobstructed pelvicalyceal system from a dilated and obstructed system.[2] Ultrasonography and diuretic renography are the two tools used for the evaluation of these cases. While sonography gives an anatomical picture of the degree of dilatation, renography gives an insight into the functional ability and drainage patterns of the dilated renal units.[3] The evaluation of these renal units is essential to prevent unnecessary surgery and diagnose obstruction at the earliest before irreversible renal functional damage occurs.[4]

Since its first description by O'Reilly *et al.*,[5] furosemide induced diuretic renogram has been used to distinguish obstructed from nonobstructed systems by using t ½ values and studying the renogram curves.[6] Although these parameters are often used by clinicians to diagnose obstruction, many investigators have identified various factors that can influence the t ½ values and thus lead to erroneous conclusions regarding the drainage patterns.[7,8] Studies have

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found postmicturition images and gravity-assisted drainage give a better indication of impaired drainage. Normalized residual activity (NORA) is one such quantitative parameter which takes into consideration both these aspects.[9] So far, no study has compared the usefulness of t ½ and NORA to differentiate obstructed from nonobstructed systems and predict the need for surgery in infants with prenatally detected PUJ-like obstruction.

We compared the drainage patterns suggested by t ½ and NORA values in infants with presumed PUJ-like obstruction to determine which parameter can differentiate obstructive from nonobstructive dilatation and thus identify and predict the need for surgery.

MATERIALS AND METHODS

All patients from January 2014 to March 2020 presenting with prenatally detected hydronephrosis with suspicion of PUJ obstruction were evaluated. The patients included were infants with prenatally detected PUJ-like obstruction whose initial renogram had a differential renal function (DRF) of ≥40% and where the decision making has been complete, i.e., either surgery has been advised or hydronephrosis had subsided during follow-up and a decision against surgery has been taken. All infants with associated megaureter or vesicoureteral reflux and those presenting with urinary tract infection were excluded from the study.

All infants were initially evaluated with ultrasonography and a diuretic renogram either at 8–12 weeks of age or later if they had presented initially at a later age. Ultrasonography was done on an empty bladder. If the bladder was full during the sonography then it was repeated after the child voided. Often the pressure of the sonography probe was enough to stimulate voiding in infants. The infants were kept under follow-up using ultrasonography every 3 monthly and the renogram was repeated if hydronephrosis increased or parenchymal thickness reduced as compared to the initial ultrasonography. If follow-up ultrasonography showed no increase in hydronephrosis or decrease in parenchymal thickness but remained stable then the renogram was repeated after 6 months. If there was reduction in hydronephrosis on ultrasonography then the renogram was not repeated. Follow-up of patients was undertaken till decision-making was complete. It was done using ultrasonography and this done by the same sonologist in all the cases.

Diuretic renogram was done using the F0 protocol. The radiotracer used was Tc99m ethylene dicysteine (EC Renogram). 0.5 mCi of Tc99m EC was injected intravenously and dynamic images were acquired initially at 2 s per frame for 1 min and subsequently at a rate of 60 s per frame for 30 min. The dose of furosemide given was 1 mg/kg. Good hydration was achieved by breastfeeding the infants ½–1 h prior to the study.

The DRF, t ½ values and the tracer activity at 2 min and 60 min were noted. Before measuring the tracer activity at 60 min, the infants were held in upright position. The t ½ was calculated as the time taken for the activity to decrease to 50% of its maximum value.[10] NORA was calculated by dividing the tracer activity at 60 min with the tracer activity at 2 min.[11] The infants voided before taking the tracer counts at 60 min. Thus, this estimated the postmicturition gravity-assisted NORA at 60 min.

The drainage patterns were classified into good, partial, or poor drainage. Using t ½ values, the drainage pattern was good if the t ½ was <10 min, partial for values between 10 and 20 min, and poor if t ½ was >20 min.[7] Values of NORA <0.5 were indicative of good drainage, values >0.5 but <1.8 indicated partial drainage, and if NORA was >1.8 it indicated poor drainage.[11,12]

The rationale behind this study was that the dilatation of the pelvicalyceal system could be obstructive or nonobstructive. If the renal pelvic emptying parameter (t ½ and NORA in this study) shows good drainage then the function of the kidney should be unaffected. Likewise, if the emptying parameter shows poor drainage then the renal unit would show deterioration of function. Only those with DRF of >40% were included as pyeloplasty is usually indicated if the DRF is <40%.

Pyeloplasty was advised if the DRF was <40% during follow-up renograms and this was taken as indicative of deterioration of renal function. The endpoint of follow-up was if pyeloplasty was advised or a decision against surgery was taken.

The statistical analysis was done using Medcalc, version 19.3.1 (https://www.medcalc.org). Chi-square tests were used along with linear regression analysis, to determine the significance of the drainage pattern and its correlation with the need for surgery. The $P = 0.05$ was taken as statistically significant.

RESULTS

183 patients with PUJ-like obstruction were seen during the study period of which 135 were children and of these 67 were infants. A total 34 patients, 31 males and three females, met the inclusion criteria. Nineteen cases had hydronephrosis on the left side while 15 had right side hydronephrosis. The minimum age at the time of the first renogram was 2 months while the maximum was 12 months (mean age was 6.08 months). The minimum follow-up was 3 months while the maximum follow-up was 5 ½ years with an average follow-up of 26 months.

Table 1 shows the distribution of cases as per the drainage patterns defined by t ½ and NORA. The correlation of

coefficient between these two parameters was –0.1716. Table No. 2 shows the cases qualifying for surgery and those not needing pyeloplasty and their correlation with the drainage patterns as predicted by t ½ and NORA. It was found that drainage patterns suggested by t ½ did not correlate with the need for pyeloplasty or managing conservatively ($P = 0.69$) while drainage patterns suggested by NORA had a significant correlation ($P = 0.0015$). By regression analysis, the P value for NORA was < 0.0001 while that t ½ was 0.0813.

DISCUSSION

Prenatally detected PUJ-like obstruction is a clinical dilemma as the onus to differentiate a nonobstructive from obstructive dilatation lies with the treating clinician. Nonobstructive dilatations show gradual regression of hydronephrosis and obstructed systems require surgical intervention. Obstruction has been defined as impediment to the passage of urine which is significant enough to cause deterioration of renal function.[3] A diuretic renogram is often used for functional evaluation of these renal units. Renal emptying parameters determine the impediment to flow of urine which suggest the possibility of deterioration of renal function. It is important that such renal units be identified at the earliest so that intervention can be done before irreversible loss of function occurs. Since the initial description of a well-tempered renogram, t ½ values have been used to categorize renal pelvic emptying into good, poor, or partial drainage. However, many investigators found that the pattern of drainage as suggested by t ½ values does not always correlate with the need to either undertake or defer surgery.[8,13-15] Many factors are attributed to this discrepancy but among them the effect of gravity and the reservoir effect of the dilated renal pelvis are thought to be important.[7,8,15-17] To improve the predictive ability of renal pelvic emptying parameters to determine the need for surgery or conservative management, investigators have studied other quantitative parameters like NORA. It is calculated by dividing the uptake values at 60 min (after voiding and having the patient in upright position) with those at 2 min. Thus, it takes into consideration the reservoir effect, effect of gravity and the effect of a full bladder which can interfere with bladder emptying.[18,19]

Table 1: Comparison of drainage pattern suggested by t ½ normalized residual activity

Drainage by NORA	Drainage by t ½ parameters			Total
	Good	Partial	Poor	
Good	2	2	18	22
Partial		5	5	10
Poor		1	1	2
				34

NORA=Normalized residual activity

Table 2: Decision for surgery compared to drainage parameter defined by t ½ values and normalized residual activity

Decision	Drainage pattern as per t ½ values			Drainage pattern as per NORA		
	Good	Partial	Poor	Good	Partial	Poor
Surgery not advised	2	7	19	21	7	0
Surgery advised	0	1	5	1	3	2

NORA=Normalized residual activity

In this study, we compared the drainage pattern as suggested by t ½ values and NORA in patients who had good function, i.e., DRF >40% at the time of presentation. We aimed to assess which drainage pattern would predict either the need for surgery or that intervention would not be needed in future. Of the 28 patients who did not need surgery 21 showed good drainage on NORA while only two showed good drainage by t ½ parameters. In the same subgroup, 19 patients had t ½ >20 min suggestive of poor drainage but none of these needed surgery during follow-up. Of the six patients who needed surgery, only one showed good drainage by NORA while three showed partial drainage and two showed poor drainage. In the same subgroup, five showed t ½ >20 min.

Duong *et al.* compared ultrasonography with various renogram parameters and found NORA to be a better indicator of renal pelvic emptying.[20] Beatović *et al.*, in their study, found that NORA had better specificity to diagnose obstruction than conventional renogram parameters.[21] Piepsz *et al.* in their study found NORA to be a reliable parameter of renal output which can be used almost independent of the level of renal function and they found that it is not affected by the timing of furosemide injection.[12]

Many studies have found that evaluation of response to furosemide in a child should include postmicturition images and images after change in child's posture (erect position or sitting position). By doing this one avoids the effect of a full bladder and the residual renal stasis related to the supine position. These would negate the reservoir effect of a dilated renal pelvis in misinterpreting the renal drainage. NORA at 60 min is a quantitative measure of postmicturition gravity-assisted drainage.

The results of this study suggest that good drainage by NORA is more likely to be associated with regression of hydronephrosis and in these patients, the follow-up can be less stringent and repeat renograms can be sparingly used. The drawback of this study is that it is a retrospective study with a small number of patients. However, this study is the only one till date which has compared the drainage parameters predicted by t ½ and NORA with need for surgical intervention and has used deterioration of renal function as the parameter to diagnose obstruction and consequently the need for surgery.

These results need to be substantiated by a multicenter study involving a larger number of patients. Further studies are needed to determine if t ½ and NORA alone, together,

or in conjunction with other parameters can determine the need for surgery particularly in cases where they fall in a range which shows the drainage as partial or poor. If these results are established, it can make a difference in the management of children with prenatally detected PUJ like hydronephrosis with less stringent follow-ups and possibly considerably less number of renograms during follow-up. This factor does have considerable economic implications in the management of prenatally detected hydronephrosis in countries with less robust health care systems where getting renograms and having regular follow-up is often difficult and challenging.

CONCLUSION

T ½ and NORA have a significant disagreement to define drainage patterns. This study suggests that NORA can define good drainage in a much larger subset of patients with PUJ-like obstruction who eventually do not need surgery and can thus be managed conservatively. The poor drainage pattern suggested by t ½ values do not accurately predict the need for surgery.

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