

## THE ACCURACY OF DOPPLER ULTRASONOGRAPHY IN THE FOLLOWUP OF PYELOPLASTY FOR CONGENITAL PELVIURETERIC JUNCTION OBSTRUCTION

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### ABSTRACT

#### BACKGROUND

Congenital pelviureteric junction obstruction (PUJO) is a common condition needing surgery for the improvement of renal function. Followup after surgery requires imaging modalities involving radiation exposure. Doppler sonography is an alternative, which can avoid radiation.

The aim of this study is to evaluate the accuracy of Doppler ultrasonography in the followup of patients with pelviureteric junction obstruction (PUJO) undergoing open pyeloplasty.

Setting and Design- This prospective observational study was conducted in a tertiary care teaching hospital.

#### MATERIALS AND METHODS

This study comprised of 31 patients with unilateral PUJO, who underwent open pyeloplasty. The diagnosis of PUJO was made by findings on IVU or diuretic renogram. The Renal Resistive Index was evaluated using Duplex Doppler ultrasonography. A renal RI >0.7 was considered diagnostic of obstruction. Resistive Index Ratio was calculated as the ratio of RRI of obstructed to that of opposite kidney. RIR value more than 1.11 was considered as obstruction.

All patients were followed up with Doppler at 3 months after surgery and the RRI value was measured. DTPA renogram was repeated at 3 months after surgery. The data was collected and sensitivity and specificity of Doppler as a diagnostic test was calculated using DTPA renogram as the standard.

#### RESULTS

Among the 31 patients, preoperative renogram showed obstruction in 19 patients and equivocal result in 12 patients. Doppler ultrasonography showed obstruction in 16 of the 19 patients with obstructive renogram. RRI of the opposite kidney showed non-obstructive value in all patients, as did the renogram. Preoperative RIR value showed obstruction in 17 out of 19 patients. Among the 12 patients with equivocal pattern who underwent pyeloplasty, preoperative RRI was suggestive of obstruction in 8 patients, while RIR showed obstruction in 9 patients. Postoperative renogram showed non-obstructive pattern in 29 patients and obstruction in 2 patients. Twenty eight out of the 29 patients with relieved obstruction had RRI < 0.70, while 1 patient showed persistently elevated RRI as well as RIR.

#### CONCLUSION

Renogram is useful for the followup of patients who have undergone pyeloplasty and for monitoring patients with hydronephrosis under observation.

#### KEYWORDS

Pelviureteric Junction Obstruction, Hydronephrosis, Renal Resistive Index, Renogram, Diuretic Renogram, Renal Resistive Index Ratio, Doppler Ultrasound.

**HOW TO CITE THIS ARTICLE:** Bhat S, Joseph S, Paul F, et al. The accuracy of Doppler ultrasonography in the followup of pyeloplasty for congenital pelviureteric junction obstruction. J. Evolution Med. Dent. Sci. 2017;6(91):6406-6409, DOI: 10.14260/jemds/2017/1393

#### BACKGROUND

Congenital pelviureteric junction obstruction (PUJO) is a common condition with a natural history of progressive deterioration of renal function. This needs corrective surgery for the improvement of renal function.

*'Financial or Other Competing Interest': None.*

*Submission 16-10-2017, Peer Review 11-11-2017,*

*Acceptance 18-11-2017, Published 27-11-2017.*

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*DOI: 10.14260/jemds/2017/1393*



Congenital PUJO is diagnosed by diuretic renogram, computerised axial tomographic urogram (CTU) or intravenous urogram (IVU). These imaging modalities need specific preparations and at times may be difficult to interpret.<sup>1,2</sup> This can lead to diagnostic dilemma and management difficulties. Chronic renal obstruction produces a state of increased vascular resistance detectable by Doppler ultrasound as an elevation in renal resistive index (RRI).<sup>3</sup> An RRI greater than 0.7 has a sensitivity of 92%, a specificity of 88% and an overall accuracy of 90% in diagnosing PUJO in adult population.<sup>4,5</sup> Keller et al proposed the resistive index ratio (RIR), calculated as the RI of the hydronephrotic kidney divided by the RI of the opposite normal kidney as a simple and sensitive method for diagnosing functionally significant hydronephrosis.<sup>6</sup> An RIR of > 1.11 has been reported as a reliable index of obstructive dilatation.<sup>7</sup> Following

pyeloplasty, on imaging some residual dilatation usually persists.<sup>8</sup> This can lead to misinterpretation of the results by physicians who are not dealing with urological problems. This can lead to apprehension and misunderstanding regarding the success of surgery in the patient and relatives. Thus, Doppler ultrasonography can be utilised in the followup of patients having persistent dilatation of the collecting system after PUJO surgery. A persistent elevation in RI is suggestive of failed surgery.<sup>4</sup>

### Objective

To evaluate accuracy of Doppler Ultrasonography in the followup of patients with Pelviureteric Junction Obstruction (PUJO) after they have undergone open pyeloplasty.

## MATERIALS AND METHODS

### Design and Sampling

#### Design

This was a prospective observational study.

#### Study Period

Included all patients operated between October 2013 and July 2016.

#### Sampling Procedure

All patients with unilateral PUJO, who underwent open pyeloplasty in the Department of Urology in a tertiary care teaching hospital in Kerala between October 2013 and July 2016 were included in the study.

#### Study Population

Included patients who were operated with a diagnosis of unilateral PUJO diagnosed by means of IVU/ CTU or diuretic renogram. The IVU/CTU findings included enlarged kidney, dilatation of the pelvicalyceal system (PCS), delay in drainage or non-visualisation.<sup>9</sup> On diuretic renogram, one or more of the following indices of obstruction were positive in all these patients: a half-time diuretic washout ( $T_{1/2}$ ) of > 20 mins, a differential renal function of < 40%.<sup>2</sup> These patients if eligible to undergo open pyeloplasty were considered for the study during the period between October 2013 and July 2016.

#### Justification of Sample Size

Between October 2013 and July 2016, a total of 31 adult patients underwent open pyeloplasty in our tertiary care hospital. For this study, all these patients were included after obtaining an informed consent. Statistical analysis was done using the SPSS software version 16.0 and the significance was calculated using chi-square test.

#### Data

Data was collected by doing a duplex Doppler ultrasonography, which was done by a single operator on all patients and the Renal Resistive Index (RRI) was evaluated. The equipment used was GE Logiq S8 with a curvilinear transducer of 3 - 5 MHz. Doppler waveforms were recorded from interlobar and arcuate arteries at the upper, middle and lower portions, first over the obstructed and then over the contralateral kidney. Measurements were taken after a constant pulse waveform was recorded three or four times in each region. The lowest possible pulse repetition frequency without aliasing and the highest possible gain were used. The

renal RI was calculated by subtracting the end diastolic velocity from the peak systolic velocity and dividing the result by the peak systolic velocity. A renal RI > 0.7 was considered diagnostic of obstructive uropathy.<sup>7</sup> Resistive Index Ratio (RIR) was calculated as the ratio of RRI of obstructed kidney to the RRI of opposite kidney. RIR value more than 1.11 was considered as obstruction.

All these patients were followed up and Doppler ultrasonography was repeated at 3 months after surgery and the RRI value was measured by the same operator. DTPA renogram was repeated at 3 months after surgery as part of the routine followup. The data was collected and sensitivity and specificity of Doppler sonography was calculated using the DTPA renogram results as the standard.

#### Inclusion Criteria

Adult patients (> 18 years).

#### Exclusion Criteria

Patients < 18 years, patients having bilateral obstruction, solitary kidney and associated calculi were excluded from the study.

#### Ethical Issues

An informed written consent was obtained from all the patients and permission from the Institution's Ethical Committee was obtained.

## RESULTS

The study comprised of 31 patients, 11 men and 20 women. The mean age of men who underwent open dismembered pyeloplasty was 35.59 years (range 21 - 49 years) and women was 35.7 years (range 21 - 49 years).

Among the 31 patients, preoperative renogram showed obstruction ( $T_{1/2}$  > 20 min) in 19 patients and equivocal result ( $T_{1/2}$  10 to 20 min) in 12 patients. The average cortical differential function of the affected side was 30.48%.

The average cortical thickness of the kidney on preoperative ultrasound was 1.763 cm. Among the group with obstructive renogram, the average cortical thickness was 1.84 cm, while the cortical thickness in the equivocal group was 1.63 cm. Doppler ultrasonography showed obstruction (RRI > 0.7) in 16 of the 19 patients with obstructive renogram, (sensitivity 84.2%). RRI of the opposite kidney showed non-obstructive value in all patients, as did the renogram (specificity 100%). Preoperative RIR value showed obstruction in 17 out of 19 patients (sensitivity 89.4%) (Table 1, 2).

Among the 12 patients with equivocal pattern in preoperative DTPA renogram and who underwent pyeloplasty, preoperative RRI was suggestive of obstruction in 8 patients (sensitivity- 66.66%), while RIR showed obstruction in 9 patients (sensitivity- 75%) (Table 1, 2).

Postoperative renogram showed non-obstructive pattern in 29 patients and obstruction in 2 patients. The average cortical differential function after surgery was 33.42%. Twenty eight out of the 29 patients with relieved obstruction had RRI < 0.70 (specificity 96.55%), while one patient showed persistently elevated RRI as well as RIR. Two patients had persistent obstruction ( $T_{1/2}$  > 20 mins) after surgery who were also identified with RRI (sensitivity 100%) (Table 3).

		DTPA		
RRI		Obstructed	Equivocal	Total
	Obstructed	16 (84.2%)	8 (66.66%)	24
	Normal	3 (15.8%)	4 (33.33%)	7
	<b>Total</b>	<b>19</b>	<b>12</b>	<b>31</b>

**Table 1. Pre-Operative Correlation with DTPA and RRI**

		DTPA		
RIR		Obstructed	Equivocal	Total
	Obstructed	17 (89.4%)	9 (75%)	26
	Normal	2 (10.6%)	3 (25%)	5
	<b>Total</b>	<b>19</b>	<b>12</b>	<b>31</b>

**Table 2. Pre-Operative Correlation with DTPA and RIR**

		DTPA		
RRI and RIR		Obstructed	Normal	Total
	Obstructed	2 (100%)	1 (3.45%)	3
	Normal	0	28 (96.55%)	28
	<b>Total</b>	<b>2</b>	<b>29</b>	<b>31</b>

**Table 3. Post-Operative Correlation between RRI, RIR and DTPA**

**DISCUSSION**

The differentiation between obstructive and non-obstructive hydronephrosis is important during the evaluation of patients presenting with flank pain, because obstructive dilatation needs intervention.<sup>5</sup> Ultrasonography is a sensitive method for the detection of dilatation of the pelvicalyceal system (PCS), but it does not differentiate between obstructive and non-obstructive dilatation.<sup>10</sup> The information obtained on US is only anatomical and not functional. The US can be normal in the presence of obstruction and may show dilated system in the absence of obstruction. The IVU can be normal in patients with intermittent obstruction.<sup>10</sup> Dilated PCS may be present in the absence of any obstruction, as in the case of extrarenal pelvis on IVU.

In the presence of obstruction, there is vasoconstriction in the intrarenal vessels. Doppler US can be used to measure the blood flow in the intrarenal vessels. The RI is a ratio of peak systolic velocity and end diastolic velocity and is calculated by the formula: peak systolic velocity- end diastolic velocity/ peak systolic velocity. The measurement of the renal RI by Doppler ultrasonography has been proposed to be a reliable indicator of urinary obstruction.<sup>5</sup> Animal and human studies have shown that an RI of > 0.7 is abnormal.<sup>5</sup> Above this value, the dilatation is considered as significant requiring intervention. This has a sensitivity of 93% and specificity of 100%. The pathophysiology of urinary tract obstruction is reflected on the arterial Doppler waveforms.

The resistive index appears to be an effective parameter for the evaluation and followup of unilateral obstructive or non-obstructive ureteropelvic dilatation in children.<sup>11</sup>

In unilateral hydronephrosis, an RIR of > 1.1 indicates obstruction. In the present study, RIR showed better sensitivity than RRI in detecting obstruction. In patients with equivocal renogram pattern and hydronephrosis, Doppler ultrasonography helps in identifying the candidates for surgery. This study showed that Doppler ultrasonography with its sensitivity and specificity is a good option for the followup of patients with PUJO after surgery.

Doppler ultrasonography results are operator dependent; however, this has been minimised with technically improved

machines and better understanding of the vessel anatomy on ultrasound. False negative results are seen in patients with acute obstruction, mild obstruction and obstruction with markedly dilated collecting system.<sup>12</sup> Some causes for false positive results have also been identified. The RI is higher in normal young children and infants than in adults. Significant hypotension and a low heart rate appear capable of producing an elevation of RI without a true change in renal vascular impedance.<sup>13</sup> An elevated RRI value may be seen in patients with dehydration and those with acute medical renal disease.<sup>14</sup> RRI measurement after administration of diuretic and comparison to contralateral kidney improves the diagnostic accuracy.<sup>15</sup>

Doppler ultrasonography does not suffice if precise anatomical information is required. Therefore, it cannot be used as a single modality for evaluating a patient with hydronephrosis. RRI and RIR provide corroboration with the initial DTPA renogram and is considered as a non-invasive modality for monitoring the dilated collecting system under observation. Additionally, this method provides a non-invasive modality for monitoring patients after reconstructive surgery of the upper urinary tract.

**CONCLUSION**

Doppler ultrasonography is a cost effective investigation with no radiation exposure for the followup of patients with hydronephrosis. In corroboration with renogram, it can be used for the followup of patients who have undergone pyeloplasty and for monitoring patients with hydronephrosis under observation.

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