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Radiology

A PROSPECTIVE STUDY OF RENAL ULTRASOUND CHANGES AFTER PYELOPLASTY IN CONGENITAL PELVIURETERIC JUNCTION OBSTRUCTION CASES

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ABSTRACT

Purpose: We evaluated the use of renal ultrasound for monitoring pyelocaliectasis after pyeloplasty in Congenital Pelviureteric Junction Obstruction cases.

Materials and Methods: Serial ultrasound was performed to monitor the changes in the pyelocaliectasis following pyeloplasty. 43 patients who were included in the study were followed for atleast one-year post pyeloplasty. Serial ultrasound was performed preoperatively and at 6 and 12 months post operatively. The degree of pyelocaliectasis was graded as 0 to 4 according to the classification of Society For Fetal Urology. Renal parameters like renal length, pelvic diameter and renal parenchymal thickness were measured at pre-op and successive post-op scans.

Results: Preoperative ultrasound revealed grade 4 pyelocaliectasis in 9 kidneys (20.9%), grade 3 pyelocaliectasis in 17 (39.5%) and grade 2 in 16 (36.2 %). Grade were same or worst 6 months after pyeloplasty in 13/43 patients (30 %). Majority of them i.e, 37/43 (86 %) showed improvement at 1year post operatively. Improvement to grade 0 or 1 dilatation from grade 3 or grade 4 occurred in only 4 kidneys (10.8 %) at the end of 1 year. Serial ultrasound study also showed gradual improvement in the renal parameters on follow up scans at 6 and 12 months compared to the preoperative scan.

Conclusions: Improvement in renal ultrasound after pyeloplasty appears to be gradual .The renal ultrasound because of its cost effectiveness, easy availability and lack of radiation provides an accurate and suitable means for the long term follow up of the patients who undergo pyeloplasty for Pelviureteric Junction Obstruction.

KEYWORDS : .

INTRODUCTION

Pelviureteric junction (PUJ) obstruction results in a functionally significant impairment of urinary transport from the renal pelvis to the ureter.

Congenital PUJ obstruction occurs because of the intrinsic disease. A frequently found defect is the presence of an aperistaltic segment of the ureter. Because of this there is obstruction of flow of urine from renal pelvis into the ureter causing hydronephrosis of the kidney. Although most cases are probably congenital, the problem may not become clinically apparent until much later in life.

In the past children with PUJ obstruction usually presented with pain, hematuria, infection or an abdominal mass detected in early childhood. However, with the present widespread use of antenatal ultrasound an increasing number of children with PUJ obstruction are now being identified in the neonatal period.

Ultrasound is usually the initial mode of investigation to diagnose PUJ obstruction. This is confirmed by Diuretic renography and/or Intravenous urography.

Many children with PUJ obstruction will eventually undergo surgery. Andersen Hynes pyeloplasty remains the main stay of surgical treatment. Soon after pyeloplasty diuretic renograms are often obtained to document surgical success by demonstrating better urinary drainage and/or improved renal function.

However while diuretic assisted renography may be most accurate to evaluate surgical outcome in the postoperative period, renal ultrasound is more commonly used for long term follow up because it is less invasive and more cost effective, especially in our country where the availability of nuclear medicine department is limited and restricted to metropolitan cities/higher centres. Although renal ultrasound is performed regularly to document progressive improvement in renal dilatation after pyeloplasty, there have been only a few reports on the sequential renal sonographic changes expected after this procedure.

The major advantages of the ultrasound include cost effectiveness, lack of ionising radiation, widespread availability of US facility, no need of contrast material, real time imaging, non invasive nature of study and hence better compliance for long term follow up, especially in younger age group.

We reviewed preoperative and postoperative ultrasound in children or adults who underwent pyeloplasty for Congenital PUJ obstruction to monitor the changes in pyelocaliceal anatomy after surgical relief of obstruction.

AIM OF THE STUDY

1) To assess the role and efficacy of ultrasound in follow up of postoperative changes after pyeloplasty in cases of Congenital PUJ obstruction.

2) To study the post operative changes in renal units like parenchymal thickness, pelvic diameter, renal length and degree of hydronephrosis in successive ultrasound scans at follow up with interval of 6 and 12 months.

3) To compare the pre operative and post operative changes in the kidney.

REVIEW OF LITERATURE

Historical perspective:

In the studies done by Whitaker in 1975 and Koff in 1986, PUJ Obstruction was thought to result in the restriction of urine flow from renal pelvis to the ureter. As a response to the obstruction there will be renal pelvic hypertrophy and subsequent pressure induced injury leading to irreversible renal damage{18}.

Dhillon in 1998 showed that kidneys with an anterior-posterior diameter greater than 20 mm seen prenatally are certainly at greater risk for requiring surgery postnatally{18}.

According to Williams and Karlaftis in 1966, Kelalis in 1971 and Johnson in 1977, PUJ obstruction is more common in boys than in girls especially in neonatal period when the ratio exceeds 2:1{18}.

According to Nixon in 1953 and Robson in 1976, bilateral PUJ obstruction is present in 10-40% of the cases {18}.

The basis of ultrasound –the piezoelectric effect dates back as early as in 1880. The curie brothers, Pierre and Jaques first demonstrated the piezoelectric effect {20}.

Paul Langevin in England developed the method of detecting submerged submarines, his work led to the foundation of SONAR (sound navigation and ranging) and later for ultrasonic imaging{20}.

The first step towards making an anatomical imaging with ultrasound was made by Karll Dussick and Fred Dussick in 1947{21}.

Pathogenesis of PUJ O:

Pelviureteric junction (PUJ) obstruction results in a functionally significant impairment of urinary transport from the renal pelvis to the ureter.

There has been a postulation of premature arrest of ureteral differentiation near the PUJ, which represents a transition zone between intrarenal and extrarenal regions of ureteric bud differentiation, leading to the formation of an aperistaltic ureteral segment near the PUJ.

Histopathologic studies reveal that the spiral musculature normally present has been replaced by abnormal longitudinal muscle bundles or fibrous tissue. This results in failure to develop a normal peristaltic wave for propagation of urine from the renal pelvis to the ureter. {18}

The persistence of the redundant and tortuous ureters of the fetus with folds is another explanation for congenital ureteral obstruction. The pleats may become muscular and enveloped by an outer adventitial coat, creating a valve type of obstructive mechanism. The luminal diameter of the PUJ is normally smaller than the diameter of the rest of the ureter (except for the UVJ) in the fetus as well as in adults. The number of smooth muscle cells is also consistently less at the PUJ throughout development. Clinically significant PUJ obstruction may therefore represent a pathologic extreme within the spectrum of normally existing narrowing in this region.

Decreased interstitial cells of Cajal at the UPJ in children has been implicated in development of PUJ obstruction by Solari{18}

Other experimental studies have implicated transforming growth factor-β, epidermal growth factor expression, nitric oxide, and neuropeptide Y in UPJ stenosis. A less frequent intrinsic cause of congenital UPJ obstruction is true ureteral stricture.

Abnormalities of ureteral musculature have been implicated as electron microscopy has demonstrated excessive collagen deposition at the site of the stricture by Hanna.

According to Maizels and Stephens, intrinsic obstruction at the PUJ may also result from kinks or valves produced by infoldings of the ureteral mucosa and musculature.

According to Kelalis, the presence of these kinks, valves, bands, or adhesions may also produce angulation of the ureter at the lower margin of the renal pelvis in such a manner that, as the pelvis dilates anteriorly and inferiorly, the ureteral insertion is carried further proximally. In these cases, the most dependent portion of the pelvis is inadequately drained and the apparent "high insertion" of the ureteral ostium is actually a secondary phenomenon.

Causes of PUJ obstruction:

1)Congenital PUJ Obstruction.
2) Aberrant vessels causing obstruction
3) Acquired PUJ obstruction.
   - Stone disease
   - Post inflammatory or postoperative scarring or ischemia
   - Benign tumours such as fibro epithelial polyps
   - Urothelial malignancy

Clinical presentation:

Most of the children are asymptomatic. They may present with palpable mass.

Occasionally infants present with failure to thrive, feeding difficulties, sepsis secondary to urinary tract infection, or pain or hematuria related to nephrolithiasis. Urinary tract infection is the presenting sign in 30% of affected children beyond the neonatal period In the older child, episodic flank or upper abdominal pain, sometimes associated with nausea and vomiting related to intermittent PUJ obstruction, is a prominent symptom. Hematuria, which is seen in 25% of children, may occur after minor abdominal trauma. This hematuria is believed to be caused by disruption and rupture of mucosal vessels in the dilated collecting system. In the young adult, episodic flank or abdominal pain, particularly during diuresis, is a common manifestation.

Occasionally, a patient with the PUJ obstruction presents with hypertension. The pathophysiology is thought to be a functional ischemia with reduced blood flow caused by the enlarged collecting system that produces a renin-mediated hypertension{18}.

Diagnosis:

Ultrasonography:

USG is the standard method for identifying hydronephrosis in infancy. In the newborn where hydronephrosis may be transient or significantly fluctuate with time, hydration, and bladder fullness serial studies become meaningful. Worsening hydronephrosis usually indicates obstruction.

The renal parenchyma-pelvicaliceal area has been measured in ultrasound and compared with the result of conventional diuretic renography. A ratio of less than 1.6 correlates well with an obstructive process and need for pyeloplasty, whereas patients with a ratio greater than 1.6 can be safely observed. They reflect the amount of pelvicaliectasis that exists{18}.

Despite the system proposed by Ellenbogen {4}, used by S.F.U (Society of Fetal Urology), most often the postnatal hydronephrosis has been graded as mild, moderate and severe .

To best compare the results of treatment it was desirable to include a numerical grading system that could be easily learned and also have a objective grading system for comparison in future studies of hydronephrosis, instead of the earlier subjective grading system of mild, moderate, and severe.

The system for grading hydronephros is developed by Ellenbogen and used by S.F.U, should be used only after ruling out Vesicoureteric reflux {4}.

In SFU (Society of Fetal Urology) grading system, hydronephrosis is graded into 5 Grades. In this system status of pelvis is less important and status of calices is the key .

Grade 0 - No hydronephrosis,
Grade 1 -Only the renal pelvis is visualised.
Grade 2 – Few calices and not all are visualised along with renal pelvis.
Grade 3 – All calices are seen.
Grade 4 –Similar to grade 3 but compared to opposite kidney there is parenchymal thinning. SFU was founded to study the postnatal evaluation of prenatally detected anomalies of urinary tract. This SFU grading system has been used to grade both prenatally and postnatal detected hydronephrosis{4}.

Serial ultrasound measurements can monitor changes in the growth rate of the normal kidney opposite the hydronephrosis.

Renal duplex Doppler Ultrasonography has also shown promise as a means of identifying obstruction. In hydronephrotic kidneys, the RI values are generally much higher ($RI \geq 0.75$) and show obstructive pattern on diuretic renography. When these Doppler studies are modified by the addition of furosemide, the differences between obstructed and nonobstructed kidneys are further accentuated. In addition, follow-up of the patients demonstrated that the RI normalized after successful pyeloplasty.{18}

Radionuclide renography:

Radionuclide renography provides differential renal function data and an assessment of washout from the
individual kidney, suggesting the presence or absence of real obstruction .

Infants are prehydrated before the studies. ^{99m}Tc-diethylenetriamine pentaacetic acid (DTPA) or ^{99m}Tc-mercaptoacetyltriglycine (MAG3) is used.

DTPA is exclusively excreted by glomerular filtration; it provides an indirect means of measuring the glomerular filtration rate (GFR). Differential GFR can be determined by comparing the amount of uptake in each kidney during the first 1 to 3 minutes after intravenous injection.

MAG3 is cleared by the kidneys by secretion in the proximal tubules and remains essentially within the intravascular space. This provides a

high target-to-background ratio, good image quality, and more accurate numerical values, particularly when the kidney function is low or immature.

The rationale for either placing a catheter in the bladder prior to the initiation of the study or acquiring a postmicturition image at the end of the dynamic diuretic renogram(well tempered renogram) is that a full bladder can inhibit drainage from the pelvis.

If a kidney with antenatal unilateral hydronephrosis is shown to maintain a stable differential renal function and pelvic diameter, this kidney is by definition not obstructed.

Normal three phases of the renogram include uptake, a peak, and a falling third phase. The slope of the uptake phase depends on the differential renal function. The peak of the renogram varies depending on the combination of pelvic volume and timing of the diuretic challenge. Thus, the lower the differential renal function and bigger the renal pelvis, the longer it takes to achieve a renogram with all three phases.

Radionuclide renography helps define whether obstruction exists. Symmetric uptake and good washout in the kidney is by definition not obstructed. In hydronephrotic kidneys, there is a small difference in the differential function of the affected kidney compared with its contralateral mate and the Lasix renogram shows some impairment of drainage.

Repeat renal scan after few months will determine the trend because an ongoing partial obstruction would deteriorate and further decline in the overall renal function and thereby cause worsening in the washout curve.

A snapshot of the kidney's function over time can be helpful in deciding whether surgery is necessary or not. Postoperative renal scan can provide an assessment of the overall residual function in the kidney.

Another study at 6 to 12 months following a successful pyeloplasty can be obtained for accurate assessment of the residual renal function.{18}

Intravenous urography:
IVP has largely been superseded by Radionuclide renography.

In cases of Intermittent PUJ obstruction, intravenous pyelogram is an ideal study to define the anatomy and is readily available at most hospitals, and can generally be done on short notice when a patient presents to an emergency department. IVP depicts the pelvicaliceal anatomy and renal function to some extent.

Standard IVP protocol can be modified and individualised to each patient depending on the requirements and thereby reduce the patients radiation dose. The disadvantages are it takes long time to obtain full series ,i.e including the delayed pictures, radiation dose, contrast morbidity, and poor visualisation of Pelvi calyceal system in marginal functioning kidneys. {18}

Magnetic Resonance Imaging:
Ultrafast magnetic resonance imaging (MRI) offers unique advantages for evaluating renal blood flow, anatomy, and urinary excretion.

MRI urography is being investigated to define urinary tract anatomy, calculate differential renal function, and assess urinary tract obstruction.

In comparison with ultrasonography and nuclear renography, dynamic contrast enhanced MRI is superior.

MR urography has been shown to be as sensitive, more specific, and of greater diagnostic efficiency than renal scintigraphy. Further refinements in dynamic contrast enhanced MR urography include the calculation of renal transit time and differential renal function. The images obtained with the heavily T2-weighted sequence provide the basis for a precontrast maximum intensity projection of the collecting systems, ureters, and bladder. The acquisition of 3 D dynamic postcontrast gradient-echo images is initiated. The renal transit time (RTT) was then calculated following archiving of all the images.

There is a excellent correlation between the $t_{1/2}$ of renal signal decay following furosemide administration and the RTT, showing that both tests yield meaningful information on response of the diuretic challenge.

MRI does not involve ionizing radiation so that multiple follow-up studies can be performed to monitor hydronephrosis. This must be balanced with the higher expense, need for sedation, and higher frequency of adverse reactions to the contrast agent.

Data acquisition from MR urography is being evaluated to calculate an index of glomerular filtration.

Research is ongoing with diffusion and blood oxygenation level–dependent imaging of the kidney being explored. {18}

Pressure flow studies:
Whitaker defined obstruction in the kidney as impedance to flow such that proximal pressure must be raised to transmit the usual flow rate through it. After placing catheters into the renal pelvis and bladder and infusing fluid at a rate of 10 mL/sec into the kidney, the intrapelvic pressure of the kidney is measured. A differential pressure between kidney and bladder could then be indicative of obstruction to the kidney.

The pressure decay half-life reflects both efficient urine transport and the relative compliance and volume of the collecting system**.** Further refinements with this technique include ante grade nephrostomy and measurement of the ureteral opening pressure.

In all patients with a renal pelvic pressure greater than 22 cm H_2O there is definitive evidence of obstruction . Pressures between 15-22 cm H_20 are equivocal, and pressures below 15 cm H_2O is negative for obstruction.{18}

The Whitaker test has no value in calculating outflow resistance in UPJ obstruction. A pressure-flow study was found to be superior to the Whitaker test and allowed categorization of the patients requiring surgery or observation.

Surgical repair:
Open techniques:
1) Flap type
2) Incisional- intubated type
3) Dismembered (Anderson –Hynes pyeloplasty): Most commonly employed.

Minimally invasive techniques:
1) Endoscopic approaches
2) Laparoscopic and Robotic Pyeloplasty

Dismembered Pyeloplasty (Andersons Hynes Pyeloplasty)
Universal acceptance of this procedure is because of its (1) broad applicability, including preservation of anomalous vessels; (2) excision of the pathologic PUJ and appropriate repositioning; and (3) successful reduction of excess ,redundant pelvis **.** {18}

Surgical approaches, including anterior sub costal, flank, and posterior lumbotomy.

Postoperative Follow up
Generally one renogram study is done at 3 months post-op to document the improvement in renal function and then subsequent follow up is done with ultrasound studies.

In a prospective study done by C. Amling, S. O'Hara et al {1}, patients underwent serial ultrasound evaluations for the changes in the pyelocaliceal dilatation for two years after pyeloplasty.

Of 104 children 0 to 12 years old who underwent pyeloplasty, 44 (47 renal units) were monitored with serial ultrasound for at least 2 years. Patient ages at pyeloplasty were 0 to 3 months (17), 4 to 12 months (8), 1 to 6 years (13) and 7 to 12 years (6). Preoperative and postoperative ultrasound was reviewed by a single pediatric radiologist blinded to the date of surgery. The degree of pyelocaliectasis was graded as 0 to 4 according to the classification of the Society for Fetal Urology{17}.

Preoperative ultrasound revealed grade 4 pyelocaliectasis in 26 kidneys(55 percent) and grade 3 disease in 21 (45 percent). Grade was the same or worse one month after pyeloplasty in the majority of kidneys (92 percent) studied at this interval. Of the 47 renal units assessed ,43 (91 percent) showed improvement in pyelocaliectasis at the postoperative follow up ,with duration varying from 2-9 years.

Of these, only 38 percent of the kidneys improved during the first 6 months of follow up, while 81 percent were improved 2 years postoperatively.{1}

Improvement to grade 0 or 1 dilatation (complete resolution) occurred in only 9 kidneys (19 percent).

The rate of resolution of pyelocaliectasis was not related to preoperative grade or patient age at
pyeloplasty.

They concluded that improvement on renal ultrasound after pyeloplasty appears to be gradual. Less than half of the patients had improvement in the initial 6 months after pyeloplasty and pyelocaliectasis rarely resolved completely.{1}

In another study by, Kis E, Verebely T, Kovi R, Mattyus I{3} they similarly conducted a prospective study of renal units post pyeloplasty in children and about 92% of them showed improvement in hydronephrosis. They concluded that resolution of hydronephrosis after surgery is relatively slow, but parenchymal growth is rapid. Mild postoperative pelvic dilatation is frequent and doesn't indicate continued obstruction.

In another retrospective study in Pubmed, 'Screening Ultrasound follow-up after Pediatric Pyeloplasty {19} was done to investigate whether an initial ultrasound (US) adequately identifies those patients who need further investigation and possibly intervention, while decreasing instrumentation and radiation exposure. They retrospectively reviewed pediatric open pyeloplasty cases performed between 1999 and 2007. Of 116 patients reviewed, 49 met the inclusion criteria of unilateral pyeloplasty with pre- and postoperative US and mercaptoacetyltriglycine (MAG-3). Hydronephrosis was judged by anterior and posterior pelvic diameter and caliectasis. Change in renal function on MAG-3 was defined as increase or decrease in function >5%.

Results - Out of 49 patients, 42 (85.7%) showed improved or stable hydronephrosis postoperatively and 7(14.3%) showed increased hydronephrosis (worsening){19}. Of 42 patients with stable or improved hydronephrosis, 41 (97.6%) also had stable or improved function on MAG 3.{19}

Comparatively, of 7 patients with increasing hydronephrosis, 2(28.6%) showed deteriorated renal function, P = .05. They concluded that Post pediatric pyeloplasty imaging should aim to identify those who require further intervention. And that 'at-risk' patients can be identified with a sentinel US and selectively determine who needs further MAG-3 investigation.{19}

Tapia and Gonzalez{14} also demonstrated improved ultrasonic appearance in 36 of 38 renal units (94%) and complete resolution of caliectasis in 71%.

In the study conducted by Kis E, Verebely T, Kovi R, Mattyus {3} to document the renal ultrasound changes after pyeloplasty on 88 patients, after 1 year follow up, pelvicaliectasis improved in 76% cases.

MATERIALS AND METHOD

The study was conducted in the department of Radio Diagnosis, Sri Sathya Sai institute of higher medical sciences; Prashanthigram and Whitefield .The patients were referred from the Department of Urology.

We reviewed the records of 73 patients who underwent pyeloplasty for PUJ obstruction between 2008-2010. Attention was directed specifically to renal ultrasound changes.

Inclusion criteria

1.Only prospective patients with serial ultrasound evaluations for at least one year after pyeloplasty were included.
2.Only congenital PUJ obstruction of any age due to intrinsic defect was included in the study.
3.Only patients presenting in radiology department in SSSIHMS in Puttaparthy and Whitefield were
included.
4.Only those patients who were operated in our hospital were included in the study.
5.In cases of bilateral PUJO, only the side(renal unit) which was operated first was included in study .

Exclusion criteria

1.Patients who lacked preoperative ultrasound scans.
2.Patients with secondary PUJ obstruction like in patients of vesicoureteric reflux, megaureter, posterior
uretheral valves or neurogenic bladder were excluded from the study.
3.Patients who underwent endoscopic pyeloplasty were excluded from study.
4.Patients who did not return for follow up after surgery were deleted from the study group.

A total of 43 patients met these criteria.

The study was conducted with Logic 400 and HD 11 US machines. 3-5 MHz and 11MHz probes were used in the studies. Longitudinal scan of the kidneys was done in all the patients.

The degree of pyelocaliectasis was graded as 0 to 4 according to classification of Society for fetal urology{17}.

0-Normal kidney with intact renal sinus
1-Slightly dilated renal pelvis without caliectasis
2-Moderately dilated renal pelvis with mild caliectasis
3-Large renal pelvis with dilated calices
4-Large renal pelvis with large dilated calices, this objective degree of hydronephrosis is graded and recorded in successive ultrasound studies.

To assess renal length in the affected renal unit, renal length measurement from tip of upper pole to lower
pole were obtained for each ultrasound study.

Thickness of renal parenchyma was measured at its suspected lowest thickness level and the thickness of the parenchyma at this level was serially measured in successive US studies of that particular renal unit.

The pelvic diameter was measured at the level of renal hilum and the same measurement protocol was followed in the subsequent post operative follow up scans.

It has been the practice in our Urology department to perform pyeloplasty to relieve the obstruction in all age groups soon after the diagnosis of PUJ obstruction, in those cases where there is definitive indication for surgery.

In all cases, Andersons Hynes pyeloplasty was performed in standard fashion, spatulating the ureter after excision of the PUJ stricture and redundant renal pelvis as necessary. Ureteral stent and percutaneous nephrostomy tubes were placed at surgery only when significant inflammation was present.

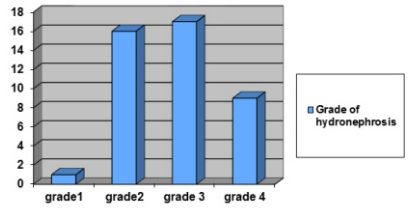
Follow up sonography was performed at 6 and12 months for all cases.

OBSERVATIONS AND RESULTS

A total of 43 patients of proven Congenital PUJ obstruction operated at SSSIHMS, Prashanthigram were studied prospectively and following observations and analysis were made.

Table 1: Grade of hydronephrosis at initial presentation

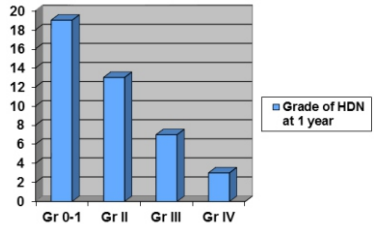
Grade of HDN	Number	%
Grade 1	1	2.3
Grade 2	16	37.2
Grade 3	17	39.5
Grade 4	9	20.9
Total	43	100



Graphical representation of grade of hydronephrosis at initial presentation

Table 2 : Grade of hydronephrosis at the end of 1 year follow up

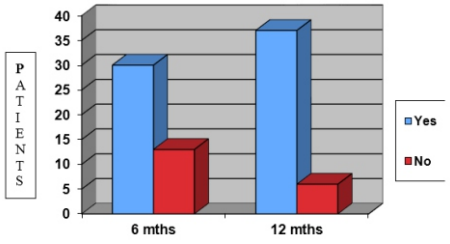
Grade of hydronephrosis at 1 year follow up	Number
Grade 0-I	19
Grade II	13
Grade III	7
Grade IV	3



Graphical representation of grade of hydronephrosis at 1 year post op

Table 3: Improvement in the radiological appearance postoperatively at 6 months and 12 months

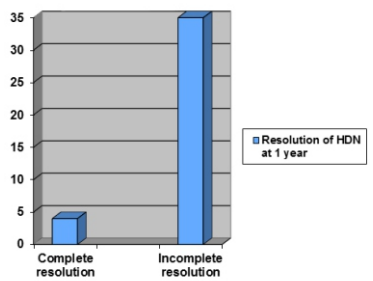
	At 6 months		At 12 months	
Postoperative improvement	Number	%	Number	%
Yes	30	69.7	37	86
No	13	30.3	6	14
Total	43	100	43	100



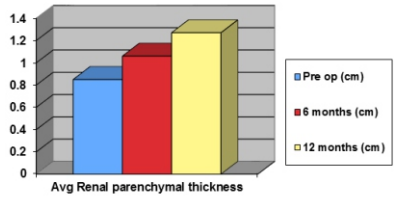
Graphical representation of the improvement in the radiological appearance postoperatively at 6 and 12 months

Table 4: Resolution of the hydronephrosis at 1 year

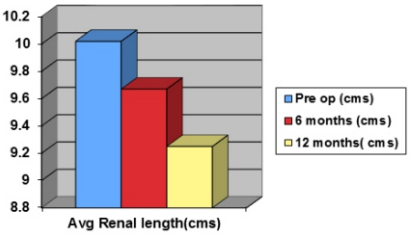
Resolution of hydronephrosis	Number	%
Incomplete resolution (grade2-4)	35	89.2
Complete resolution from grade 3-4 to grade 0-1	4	10.8
Total	37	100



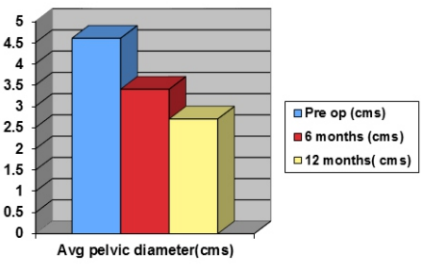
5: Improvement in the average parenchymal thickness at 6 months and 12 months postoperatively.



6 : Improvement in the average renal length at 6 months and 12 months postoperatively



7 : Improvement in the average pelvic diameter at 6 months and 12 months postoperatively



Parameters	Total	Average	Z Value
Average renal parenchymal thickness	36.9 45.7 54.9	0.85 1.06 1.27	-1.4 Significant
Average renal pelvic diameter	199.4 147.6 116.4	4.6 3.4 2.7	4.3 Significant
Average renal length	431 416.2 398.1	10.02 9.67 9.25	1.28 2.83 Not significant Significant

>1.645 : significant
<1.645: insignificant

OBSERVATIONS AND RESULTS

Our study included 43 patients of which 27(62.8%) were males and 16(37.2%) were females.

The patients belonged to wide age group ranging from 2year 9 months-42 years. Majority of them belonged to the first decade at the time of presentation.

17/43(39.5%) patients presented were <10 yrs, 15/43(34.8%) were between 10-25 yrs of age, 11/43(25.5%) were above 25 yrs of age.

The clinical symptoms in the descending order of frequency were flank pain in 34(79%), flank mass in 3(7%), UTI(urinary tract infection) and hematuria in 1(2.3%) patients.

Out of 43 patients, 4(9.3%) were detected antenatally by antenatal ultrasound.

In this study left kidney (23 out of 37 patients) was affected more frequently than the right kidney. Bilaterality was seen in 6(14%) patients.

Out of 43 patients, 1 patient had a horseshoe kidney and 1 was associated with duplex moiety.

In the initial presentation 17(39.5 %) patients presented with Grade 3 hydronephrosis followed by 16(37.2%) with Grade 2 and 9(20.9 %) with Grade 4 hydronephrosis according to the Grading designed by Society of Fetal Urology{17} . Only one patient(2.3%) presented with Grade 1 hydronephrosis.

Out of 43 patients followed up after surgery, 30/43 patients (69.7 %) showed improvement in hydronephrosis at 6 months radiologically .And almost 86 % (37/43) improved at the end of 1year follow up.

6/43 (14%) patients worsened or showed no improvement radiologically at 1 year follow up.

Of the 37 improved patients, 4 (10.8%) showed complete resolution of pyelocaliectasis from grade 3-4 to grade 0 or 1 at the end of one year.3 patients out of these showed complete absence of pyelocaliectasis at the end of 1 year where as 1 patient improved from grade III to grade I.

When the renal length measurements were summed preoperatively, at 6 and 12 months independently and averaged with the total number of studied patients, there was serial decrease in the average renal length at 6 and 12 months postoperatively.

An average of 7.5 mm decrease (improvement) in the renal length at 12 months was observed.

Similarly the average of renal parenchymal thickness (measured at minimal thickness) measurements were calculated which also showed increase in the thickness at 6 and 12 months postoperatively.

An average improvement of 2mm at 6 months and 4 mm at 12 months was observed.

The average renal pelvic diameter at the renal hilum preoperatively measured 4.6 cm, which reduced to 3.4 cm at 6 months and 2.7 cm at 12 months post op. Serial reduction in the pelvic diameter was observed.

Based on the statistical data, there is significant improvement in the average renal parenchymal thickness and pelvic diameter at 6 and 12 months (Z value > 1.645)

However the decrease in the average renal length is not statistically significant at 6 months (Z value < 1.645). At 12 months follow up statistical data shows significance with Z value > 1.645.

DISCUSSION

Pyeloplasty in children with congenital PUJ obstruction is performed to improve urinary drainage from the dilated collecting system and thereby preventing the renal damage. Surgical success is usually demonstrated radiographically either by improvement in the drainage and/or function on the postoperative diuresis renogram and by decreased pyelocaliectasis on serial renal ultrasound.

Diuretic renography becomes unsatisfactory as there are significant number of indeterminate results and various methodologies for the qualification of excretory half time. There have been attempts to standardize diuretic renography in the evaluation of PUJ obstruction, including the recent description of the well-tempered renogram. But major disadvantage is its invasiveness in the young children, requiring intravenous hydration and insertion of a bladder catheter. And also Scintigraphic studies are more expensive and time consuming than other imaging modalities and they provide minimal anatomical information. Thus the diuretic renography is the gold standard to document surgical success in the early post op period, its relative invasiveness and expense makes it impractical for extended monitoring of many children.

In contrast to nuclear renography, renal ultrasonography is an imaging study of choice that is well suited for long term follow up of patients after pyeloplasty especially in our country where the availability of nuclear studies is limited. Renal ultrasound findings in PUJ obstruction correlate poorly with the degree of functional obstruction in the immediate post operative period. Ultrasound has several advantages over nuclear renography for extended follow-up. Unlike renography, the primary advantages of ultrasonography are that it is

1. Non-invasive and easily available.
2. Provides an accurate assessment of renal pelvis and caliceal dilatation.
3.Renal ultrasound is also the best study to assess renal parenchyma thickness, echogenecity and renal
growth postoperatively.
4.Cheaper than nuclear study
5. No radiation exposure as in nuclear study.
6.In addition, the routine use of renal ultrasonography in the evaluation of postnatal hydronephrosis has led to the development of grading system that allows accurate and reliable comparison of serial examinations. The grading system developed by the Society for fetal urology{17} has been adopted by some investigators as a standard measure of pyelocaliectasis in the evaluation of postnatal hydronephrosis.
7.Increased compliance from patients for follow up as it is non invasive, quick, and less costly.

Most published series on pyeloplasty describe improvement in the renal pelvicaliceal dilatation following surgical resection of PUJ obstruction. Previously others performed IVP preoperatively and postoperatively to assess the surgical success after pyeloplasty. Recently 2 reports indicated improved ultrasonic appearance as well.

In our study 37 out of 43 patients (86%) showed improvement in pyelocaliectasis at the end of 1 year of study. At 6 months 69.7% (30/43) of patients showed improvement radiologically which increased to 86% (37/43) at the end of 1 year.

Our study correlates with that of C L. Amling' s study{1} and also with that of Neste{15} and Kis E et.al {3}.

Christopher L. Amling and Sara M. O'hara{1} in their study in 47 patients with PUJ obstruction after pyeloplasty, 81% showed improvement in pyelocaliectasis in 2 years time.

Neste et al{15} performed renal ultrasound to evaluate disease Grade and renal pelvic diameter after pyeloplasty in 50 patients with PUJ obstruction. They noted improvement pyelocaliectasis in 72% of the patients and improvement in pelvic diameter in 84% ,by 2 years postoperatively.

In another study by Tapia and Gonzalez{14} ,they found improvement in significantly more number of the patients as compared to our study with improved ultrasonic appearance in 36 of 38 renal units (94%) and complete resolution of caliectasis in 71%.

In the study conducted by Kis E et al{3} to document the renal ultrasound changes after pyeloplasty on 88 patients, after 1 year follow up, pelvicaliectasis improved in 76% cases.

There was no resolution of caliceal and renal pelvic dilatation, even partially, in our series in 6/43(14 %) at end of 1 year. In the majority, 37/43 (86%) of cases there was some improvement in ultrasonic appearance during postoperative follow-up.

Although complete resolution of caliceal and renal pelvic dilatation was rare in our series. That is resolution to grade 0 or 1 from grade 3-4 occurred in only 4/37 patients (10.8%).

Our finding is similar to that of Amling et al {1}, who found improvement to grade 0-1 in only 19 % of patients.

While improvement in pyelocaliectasis following pyeloplasty has been well documented, relatively little has been reported about the temporal pattern of this decrease in pelvicaliceal dilatation. In the series of Neste et al postoperative ultrasound and diuretic renograms were reviewed in patients monitored on an average of 26 months after pyeloplasty. Improvement in ultrasound appearance was much more gradual than the change in renographic pattern with renographic improvement observed well in advance of that seen on ultrasound. While 72% of ultrasound studies revealed improvement during follow up, only 43% showed improved pyelocaliectasis in the first 6 months after surgery.

Our findings were little different with ultrasound showing improvement in 69.7% of our patients at 6 months and 86% showing improvement at 12 months following pyeloplasty.

The improved ultrasonic appearance of renal units in our hospital may

be due to the type of pyeloplasty being performed. Invariably, in all our cases, the type of surgery was Anderson Hynes pyeloplasty, where the redundant pelvis is excised and diseased part of PUJ and excess tortuous ureter is removed.

In the Neste's{15}study they have not mentioned about the type of pyeloplasty done as it changes the findings because in endoscopic procedures like endopyelotomy the changes in hydonephrosis is not significant as they do not excise the redundant pelvis .

Tapia and Gonzalez{14} reported that of the 38 renal units with grade 3 or 4 disease preoperatively, 29 (75%) had improvement to grade 2 or less between 6 and 12 months after pyeloplasty. In our study out of 26 renal units which had grade 3 or 4 HDN, 15 (58%) showed improvement to grade II or less at the 12-month follow up.

Our findings are not inconsistent with earlier reports using IVP to assess pyelocaliectasis after pyeloplasty. In these series return to normal radiographic appearance after pyeloplasty was noted in only 0 to 10% of cases. It appears from these studies and our data that, although collecting system dilatation improves in the majority of patients following pyeloplasty, return to normal ultrasonic appearance is rare after 12 months of follow -up and may be with further extended follow up the radiological improvement increases further with maximal improvement noted at 2-3 yrs as per conventional teaching. Since our study duration is limited to 12 months the extended follow up of these patients is not possible.

Most common failure of pyeloplasty is noted within first year after surgery. And the most common features suggested are noted clinically, that is symptoms of recurrent loin pain and recurrent urinary tract infections. In our study we did not note any clinical failures, i.e. failed pyeloplasty. The reason may be that since our centre is a tertiary referral centre with expertise available to handle paediatric urology and also due to good volume of cases. Though we did not objectively assess the success of surgery like using pain-scoring scales and documenting the UTI, we subjectively evaluated the symptoms by asking verbally about their symptom improvement. All patients noted significant improvement like pain relief. The questions asked were 1) Is your pain relieved after surgery 2) Are you having any urinary complaints post op 3) Overall are you feeling better postoperatively.

The other reason may be the nature of surgery. It is well documented in literature that the success of open pyeloplasty is in the region of 90-100 % {18}.Therefore in our present era with improved surgical expertise and refinement and anaesthesia facilities, failure after open pyeloplasty is rare , at least in good institutes (tertiary care centres) who are handling good volume of these cases.

In our study, 6/43 (14%) patients who did not show any improvement ultrasonically, had clinical improvement. This factor also confirms that it is not important to document radiological improvement to confirm the success of surgery. This may be due to the nature of lesion as the obstruction is only because of physiological adynamic segment of PUJ and this is where the importance of diuretic renogram comes into picture.

These cases often show improvement in curves and the function and confirms the surgical success. We did not compare the ultrasound and renogram as this was beyond the scope of our study and also because in our institute there is no protocol for sending all patients postoperatively for diuretic renogram unlike for ultrasound study. Only those patients who are not improved clinically are sent for renogram study. We feel that this protocol is a prudent approach in our country considering the cost of renogram ,the invasive nature of study, as majority of patients are children and also need for sedation and catheterisation in well tempered renogram.

Due to long term obstruction, the pelvicaliceal system gets remodelled and due to intrinsic changes of collagen and urothelial for long duration the improvement in dilatation is not complete like in normal kidney even though the operation is successful and the patient is relieved of symptoms. This may be due to the caliceal memory, also called as residual dilatation And hence it is significant to know that just the mere absence of improvement in dilatation doesn't signify the failure of surgery and the radiological improvement may be noted gradually and it may take years to notice significant improvement radiologically. Even in our study we found that 14 % of our patients did not have any improvement in pelvicaliceal dilatation, but they were free from symptoms.

In our study, we have measured minimal parenchymal thickness in all the renal units preoperatively, at 6 months and at 12 months and average parenchymal thickness was calculated. Average renal parenchymal thickness preoperatively was 0.85 cm, at 6 months was 1.06 cm and at 12 months was 1.27 cm. There was gradual improvement in the renal parenchymal thickness with the resolution of the pyelocaliectasis. An average improvement of 2mm at 6 months and 4 mm at 12 months was observed.

We also measured the longitudinal renal length from upper pole to lower pole, all the measurements were averaged. Average renal length preoperatively was 10.02 cm which showed gradual decrease to 9.67 cm at 6 months and 9.25 cm at 12 months When the sum of renal length measurements preoperatively, at 6 and12 months were calculated independently and the sum averaged with the total number of studied patients, there was serial decrease in the renal length at 6 and 12 months postoperatively. An average of 7.5 mm decrease (improvement) in the renal length at 12 months was observed.

The average renal pelvic diameter at the renal hilum preoperatively measured 4.6 cm, which reduced to 3.4 cm at 6 months and 2.7 cm at 12 months post op. Serial reduction in the pelvic diameter was observed.

Based on the statistical data, there is significant improvement in the average renal parenchymal thickness and pelvic diameter at 6 and 12 months (Z value > 1.645)

However the decrease in the average renal length at 6 months is not statistically significant at 6 months (Zvalue < 1.645). At 12 months follow up statistical data shows significance with Z value > 1.645

LIMITATIONS OF OUR STUDY

1) Cases were followed up only for a period of 1 year
2) Improvement in renal units were not correlated with that of diuretic renogram study

SUMMARY

43 patients suspected of having Congenital PUJ obstruction were imaged prospectively. In all the cases ultrasound was performed. Those cases who underwent Andersons Hynes pyeloplasty were identified and subsequent follow up scans were obtained at 6 months and 1 year.

On ultrasound various parameters were measured like renal parenchymal thickness, renal length, pelvic diameter and grade of hydronephrosis in preoperative scans. All these parameters were obtained in the subsequent postoperative scans as well and compared.

Congenital PUJ obstruction was found more common in boys. Left kidney was affected more frequently than the right. Bilateral PUJ obstruction was seen in 14% of cases. Peak age of presentation was between 1-2nd decade of life.

Though the clinical presentation was variable, most of the patients presented with flank pain.

Majority of the cases 37/43(86%) showed improvement in the renal parameters and grade of hydronephrosis.

Complete resolution occurred in 4/37 (10.8 %) cases. There were a few failures (14%) who did not show any improvement.

Ultrasound showed improvement in 69.7% of our patients at 6 months and 86% showing improvement at 12 months following pyeloplasty

Serial ultrasound study showed improvement in the renal parameters like renal parenchymal thickness, renal pelvic diameter and renal length post pyeloplasty.

In postoperative cases of congenital PUJ obstruction, Ultrasound is the modality is choice for the extended follow up and documenting the improvement in the renal parameters like renal length, renal parenchymal thickness and renal pelvic diameter.

Ultrasound is also preferred as it is non invasive, widely available and

more importantly lacks radiation.

CONCLUSIONS:

The non-invasiveness and reproducibility of this imaging modality make it well suited for long term monitoring of improvement in renal dilatation and assessment of renal growth after pyeloplasty.

Our data and those of other series demonstrate that changes in renal ultrasound appearance after pyeloplasty are gradual, usually occurring during many months.

We propose that diuretic renogram for follow up may be reserved for those cases who are not improved clinically and on ultrasound study.

Ultrasound showed improvement in 69.7% of our patients at 6 months and 86% showing improvement at 12 months following pyeloplasty Congenital PUJ obstruction is more common in boys.

Peak age of presentation is 1-2 nd decade of life.

Left sided PUJ obstruction is more common than the right.

Bilateral PUJ obstruction is seen in 14% of the cases.

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