



## Review Article

# POSTOPERATIVE RESULTS FOLLOWING SURGERY FOR PUJO IN CHILDREN

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Pelvi-ureteric junction obstruction (PUJO) is among the most common causes of congenital urinary obstruction. With the introduction of antenatal sonography and its universal acceptance a larger number of cases of asymptomatic hydronephrosis are picked up early in the natural history of the disease. However, this hydronephrosis tends to improve or resolve spontaneously in a large number of cases and has forced the treating personnel to alter their understanding of the disease process and redefine the indications for surgical management. In today's scenario, we are equipped with a lot many options directed towards the management of PUJ obstruction. The spectrum of these options ranges from watchful waiting at the conservative end to balloon dilatation, endopyelotomy and pyeloplasty which could be open, laparoscopic or robotic. Then we have certain exclusively salvage options like ureterocalicostomy or even nephroureterectomy at the extreme end of the spectrum. However, there are a lot many controversies that surround the management of PUJO.

The main indication for performing pyeloplasty include; a symptomatic child with pain, sepsis, lump and deteriorating renal functions. A frusemide induced renal scan showing not only the dilatation but also the retention of the isotope even after 4 hours and an obstructive pattern of the drainage curve (in absence

of any distal obstruction). The percentage of the function on either side is not important and only suggests that kidney is still coping up the obstruction at its enlargement to maintain good function. Age is also no bar for surgery. If the obstruction is established, specially in bilateral cases, with clinically a tense lump/s palpable, a pyeloplasty is indicated even during the first month of life. Indications for nephrectomy are quite rare these days and include; a very poorly and non functioning kidney with no return of function even after a trial of a nephrostomy drainage, a very thin walled kidney with sepsis, pyonephrosis often associated with hypertension and multiple stones. In children with hydronephrosis associated with hugely dilated duplex system with bizarre anatomy, horse shoe kidney, low placed pelvic kidney and crossed fused renal ectopia, an intra-abdominal approach is recommended.

### Criteria to define post operative results following surgery for PUJ Obstruction

For proper assessment of the results of any form of intervention, the ideal situation would be to have a comparison of the same with the natural history of the disease, untreated. However, there are hardly any studies that dwell upon the long term follow up of the pediatric patients with symptomatic hydronephrosis. Still, we have reports on the development of symptoms in previously asymptomatic hydronephrosis. The long term follow up of this sub-group of patients serves as good evidence in favor of the effectiveness of surgery in relieving the symptoms and hence clinical improvement.

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The post operative results following pyeloplasty can be considered under several subheadings:

- Resolution of the patient's symptoms clinically
  - o Flank pain
  - o Lump in the abdomen
  - o Urinary tract infection
- Resolution or improvement in hydronephrosis
  - o Improvement in SFU graded Hydronephrosis
  - o Temporal axis growth of the ipsilateral kidney
  - o Gradual increase in renal parenchyma
- Radionuclide Studies<sup>58</sup>
  - o Improved drainage ( $t_{1/2}$ ) on a radionuclide renal scan
  - o Stabilized or improved differential function

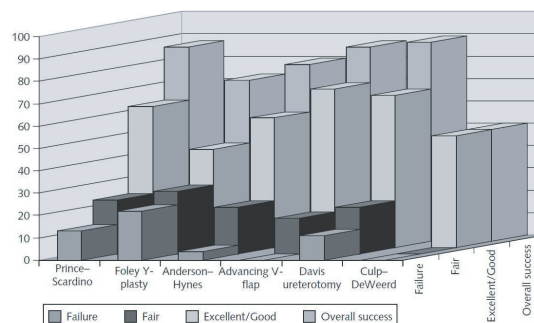
### Factors Governing the Post Operative Results

A successful pyeloplasty begins preoperatively with a proper decision with regard to the timing of surgery. The post operative results will depend upon the following factors:

- Age at surgery.
- Degree of obstruction.
- Presence or absence of infection.
- Differential Renal Function
- Tissue handling and the type of sutures used during surgery
- Excision of redundant renal pelvis
- Providing a dependent, tension free and secure anastomosis
- Taking care of the crossing vessels to the lower pole
- Prevention of post operative infection
- Use of drainage procedure – a stent or a nephrostomy tube.
- Early detection and management of post operative complications

### Historic Data

The approach to the repair of PUJO has evolved from the simple ureteral advancement procedures to the currently gold standard Anderson Hynes Dismembered Pyeloplasty (first described in 1949 by the British Plastic and Urologic Surgeons JC Anderson and W Hynes<sup>1</sup>) to Laparoscopic and Robotic assisted pyeloplasties. The results with the previously described techniques were inferior to what we are used to with the modern dismembered pyeloplasty techniques.



**Fig.-1: Historic Success Rates from 1961 to 1982.** (Adapted from Prince and Scardino<sup>2</sup>, Tynes et al<sup>3</sup> and Jenny Yiee and Duncan T. Wilcox<sup>4</sup>.)

The Davis intubated ureterotomy was described for the first time in 1943. This technique relies upon the secondary epithelization after the strictured portion of the ureter has been incised from at least 1 cm above to 1 cm below the stricture. Proximal diversion of the urine is established with a nephrostomy and a stent is placed across the ureterostomy. Intubated ureterostomy is rarely used today as an open technique. A report by Ackerman and Frohmuller<sup>5</sup> achieved 70 percent success in 68 cases of ureteral intubation.

Multiple large, historic series consisting mostly, but not exclusively, of dismembered repairs have reported very high success rates of the order of 99% and with minimal morbidity.

In a study by Johnston JH et al<sup>6</sup> based on 238 hydronephrotic kidneys in 219 children, a successful repair was reported in 210 out of 214 dismembered pyeloplasties which tabulates to 98%. There were 7 re-operations of which 4 were for persistent obstruction and 3 for stone formation after pyeloplasty.

In another study by Henren et al<sup>7</sup>, a success rate of 99% was reported. They have reported 152 successful pyeloplasty out of 153 done on 130 pediatric patients.

### Recent Data

Author and Year	Patients/ Kidneys	Success (%)
Poulsen et al. 1987	35	100
O'Reilly, 1989	30	83-93
MacNeily et al. 1993	75	95
Shaul et al. 1994	32/33 (2 mo old)	97
	30/33 (>2 mo old)	93
Salem et al. 1995	100	98
McAleer and Kaplan, 1999	79	90
Austin et al. 2000	135/1237	91
Houben et al. 2000	186/203	93
Casale et al. 2004 (*)	19	94
Bonnard et al. 2005 (**)	20	96

\*Transperitoneal laparoscopic, \*\* Retroperitoneal laparoscopic

109 pyeloplasties were performed. The mean age at surgery was 21.7 months and the mean post operative follow up was 44 months. Of these, 31% were diagnosed antenatally. 60% patients had a differential function of less than 40% at the time of undergoing the surgery and the  $t_{1/2}$  was more than 20 minutes in 92.5% of the patients. 3% of the patients were symptomatic with urinary tract infections and 14% with flank pain. All the patients had a perinephric drain at the end of the surgery. No collecting system drains were used. Post operatively, 98% of the patients had a significantly improvement or stabilized hydronephrosis, the renal function improved by more than 5% in 67 kidneys (61.5%), stabilized in 30 kidneys (27.5%) and it deteriorated in 12 (5%) kidneys. 76% of the patients had an improved  $t_{1/2}$ . The post operative complications included urinary infection (3.7%) and prolonged urinary leak (3.7%). A repeat pyeloplasty was required in 5 patients (4.6%) for either prolonged urinary leakage or re-obstruction with deterioration in renal function and nephrectomy in 1 (1%).

Tal et al<sup>10</sup> reported their 5 years experience based on a retrospective analysis of patients who had undergone the dismembered pyeloplasty. A total of 103 patients were included in the study. Preoperative data, short- and long-term complications and outcome were recorded. Imaging studies included urinary tract sonography and dynamic renal scans, the results of which were compared pre- and postoperatively. The mean age at surgery was 12 months and the mean follow up duration was 32.4 months. 77.5% of the cases were detected antenatally. A 8% of these patients had a history of urinary tract infection and 5% patients complained of flank pain. The use of collecting system drains was left to the discretion of the surgeon. There were no major complications and incidence of minor complications was acceptable (fever in 31.1%, urinary infection in 12.6% and urine leak in 7.8%). Postoperative outcomes were excellent, with decreased hydronephrosis in 83 patients (81%), improved renal drainage with improved  $t_{1/2}$  was seen in 90 patients (87.4%) and preserved or improved renal function in 92 patients (89%). None of the patients required a repeat pyeloplasty or a nephrectomy. There was no mortality.

#### **Post operative results following surgery for PUJ Obstruction by various pre operative criteria.**

The importance of analyzing the outcomes of surgery as a function of the pre operative criteria becomes important when we try to predict the best operative

candidates in terms of functional outcome. However, the preoperative assessment of which kidneys will benefit from such surgery still remains unreliable.

In a retrospective study by Zaccara et al<sup>11</sup>, the various preoperative parameters of unilateral PUJO in children have been analyzed with a focus towards predicting the post operative functional improvement. Pre- and postoperative data relating to renal function were obtained by renal scan for 69 patients who were operated upon for PUJO. These patients were divided into two groups: Group A (improved differential renal function) and Group B (unimproved or decreased differential renal function). The two groups were then compared with regard to

1. Age at operation
2. Presence or absence of clinical symptoms
3. Sonographic Parameters
  - a. Antero-posterior diameter of the pelvis (< or > 15 mm),
  - b. Parenchymal thickness (< or > 5 mm),
4. Renal scan based parameters
  - a. Glomerular filtration rate,
  - b. Differential renal function of the affected kidney (< or > 40%),
- c. Obstructive pattern

No correlation whatsoever was found between the two groups for any of the parameters under consideration with either parametric or non parametric tests and all attempts at logistical regression analysis failed. As a conclusion, none of the currently adopted diagnostic tests can be used to indicate which renal units will benefit from surgery through an improved renal function. The presence or absence of clinical symptoms does not appear to affect renal function either.

#### **A. Post operative results by Presentation**

There are several studies that have focused on the correlation between the post operative results following surgery for PUJ Obstruction and the clinical presentation of the patient. The results have been varied, but in general no universally acceptable correlation has been convincingly brought out so far.

Chandrasekharam v et al<sup>11</sup> showed in 68 children with unilateral symptomatic hydronephrosis, the factors associated with functional improvement after a successful pyeloplasty. An absolute increase in the

differential function of the operated kidney by over 5% was considered significant. They concluded that the split renal function tends to improve significantly up to 1 year post operatively. The difference between the split renal function pre operatively and at three months post operatively was found to be significant. Patients who presented with a mass had a slightly greater improvement in renal function than those who presented with other clinical features. It was also evident that patients aged less than 1 year at the time of surgery showed greater improvement in split renal function than older patients.

In another retrospective review by *Sutherland et al*<sup>12</sup>, data from 227 children who underwent pyeloplasty was analyzed for various parameters such as age at presentation, presenting signs and symptoms, type of surgical construction, complications and treatment and final outcome. A total of 234 pyeloplasties were performed, Group A comprised of 108 children less than 1 year old and group B comprised of 119 children more than 1 year old. Group A was characterized by antenatal diagnosis in 86 (79%), UTI in 9 (8%) and lump in 5 (4.6%) of the cases. Group B was characterized by pain in 57 (48%), UTI in 29 (24%), hematuria in 12 (10%) and prenatal diagnosis in 3 (2.5%) of the cases. The diagnosis was incidental in 13 (11%) patients. All these patients underwent a dismembered pyeloplasty. It was a non intubated repair in 99 of 114 patients in Group A and 102 out of 120 patients in group B. the post operative results were comparable in the two groups (95% in Group A vs. 96% in group B). The complication rate was also the same between the two groups.

Even Tal et al<sup>10</sup> could not establish a correlation between the outcomes based on whether the presentation was antenatal or with an episode of urinary tract infection. Although, he concluded that the patients who presented with urinary tract infections were more likely to be females, of older age groups and associated with an increased rate of complications.

A similar lack of association between outcome and age or presentation was concluded by Salem et al<sup>14</sup>. They reviewed 100 consecutive pyeloplasties performed between 9 days and 16 years of age. Results were analyzed by groups according to patient age and symptoms at presentation. Drainage half-times improved in 98% of patients and only 1 required re-operation. Improved renal function greater than 5%

was noted in about a third of each age group. Function remained stable in 68% of the kidneys and decreased in only 1. Of the improved kidneys 77% had impaired function preoperatively (40% or less of the total contribution). Those presenting with a renal mass had the greatest improvement in function. However, there was no statistically significant difference in improvement in renal function by age group or patient presentation. Regression analysis revealed that preoperative differential renal function was the only statistically significant predictor of improvement in renal function after pyeloplasty. This is well explained by the fact that well functioning kidneys have little room to improve.

### **B. Post operative results by Age**

Several studies have not been able to work out any association between the outcome and age at the time of surgery. The studies by *Sutherland et al*<sup>12</sup> and Salem et al<sup>14</sup> have already been discussed. MacNeily AE et al reviewed 75 cases of isolated unilateral pediatric PUJ Obstruction. Per cent differential function on the first renogram pre-operatively neither declined as age at presentation advanced nor did it vary according to the clinical presentation. Similarly, the changes in postoperative per cent differential function were unaffected by the age at initial presentation, manner of presentation, occurrence of postoperative complications or the surgeon. These data do not support the concept that pyeloplasty for the isolated, unilateral pelviureteric junction obstruction should be performed early to avert loss of renal function.

However, the study by Chandrasekharam v et al<sup>11</sup> concluded that patients aged less than 1 year at the time of surgery showed significantly greater improvement in split renal function than older patients.

### **C. Post operative results by Delayed Repair**

There was a time when immediate surgical repair was the dictum for treatment of Pelviureteric junction obstruction. Ransley et al<sup>15</sup> for the first time came up statistically with the concept what is now referred to as watchful waiting. In his non randomized study, he followed up 100 patients of antenatally diagnosed hydronephrosis, and relative function greater than 40%, only 23% of the patients eventually deteriorated on conservative management and required surgical correction. Not all patients who undergo surgical correction of this anomaly regain or improve upon their renal function.

Similar results have been put forward by Cartwright et al<sup>16</sup>. 33 of 45 patients with “apparent ureteropelvic junction obstruction” and relative renal function greater than 35% were followed up non-operatively and compared with the other 12 who underwent pyeloplasty in the first few months of life. No difference between the differential renal function between the two groups could be demonstrated.

Freedman ER et al<sup>17</sup> followed up 160 cases with an initial differential function of more than 40% in 140 (87.5%) cases. These were managed expectantly with renographic follow-up, usually at 24, 48, and 72 months of age. The 20 patients with reduced differential function underwent early intervention (pyeloplasty, or trial of nephrostomy drainage in those with very poor function). Follow-up in those managed expectantly showed good differential function in 135 (96.5%), despite persistence of renographic obstruction in two thirds of the cases, more than half of which have had renographic follow-up beyond 4 years. Differential function decreased to below 40% in five patients (3.5%); this was not related to the type of renographic curve or severity of the hydronephrosis. They felt that the natural history of antenatally diagnosed pelviureteric obstruction was benign and it may differ from that in older children.

Koff SA et al<sup>18</sup> went a step ahead and followed nonoperatively all neonates with unilateral hydronephrosis and suspected pelviureteric junction obstruction, regardless of the degree of hydronephrosis, shape of the diuretic renogram washout curve or *initial degree of functional impairment*. Of 104 patients 7 (7%) ultimately required pyeloplasty for obstruction, which was defined as a greater than 10% reduction in differential glomerular filtration rate and/or progression of hydronephrosis. Pyeloplasty returned renal function to pre-deterioration levels in all kidneys. In 16 patients with profound hydronephrosis and initial differential renal function less than or equal to 40% all traditional diagnostic tests for assessing obstruction, including diuretic renography washout pattern, were inaccurate in diagnosing obstruction and predicting which kidney would deteriorate. In 15 of 16 poorly functioning hydronephrotic kidneys rapid improvement in absolute and per cent differential renal function was observed and the level of initial differential renal function served as a useful guide for timing of further diagnostic studies. He also concluded that unilateral neonatal hydronephrosis was a relatively benign condition and

the risk of developing renal obstruction was relatively slight. He felt it safe to follow neonatal unilateral hydronephrosis closely and nonoperatively.

Apocalypse et al<sup>19</sup> in their study concluded that though there was a transient decline in the renal function, after repair, all three groups i.e., conservative, early surgery and delayed surgery were identical with regard to renal function on DMSA Scan.

#### **D. Post operative results by Surgical Technique**

Several surgical techniques have been described for the correction of this anomaly. They include the open pyeloplasty, the laparoscopic and the robotic pyeloplasty and the various endoscopic techniques which are discussed subsequently. The technique may also differ within the open pyeloplasty group with regard to the approach which could be via the flank region, the dorsal lumbar incision or the transperitoneal approach.

A dismembered repair as described by Anderson and Hynes is preferable to a flap type of a procedure in the pediatric population. The obstructing segment in this cohort is typically, stenotic and fibrotic and rather unsuitable for incorporation into the repair.

Wiener et al<sup>20</sup> conducted a study to compare the two approaches, viz., the flank incision and the dorsal lumbar incision. 33 consecutive children underwent simple dismembered pyeloplasty by a single pediatric urologist from 1992 to 1996. The flank approach was used exclusively in the first group of patients who underwent repair in 1992 to 1993 and the dorsal lumbar incision was used exclusively in the second group after 1993. Data were obtained from hospital and clinical records, and both groups were compared with the 2-tailed t test. The overall comparison of the two groups revealed no difference in the operating time between the two groups. However, in children older than 1 year pyeloplasty through a dorsal lumbar incision (108.5 minutes) was statistically significantly faster than the flank approach (144.4 minutes). Hospital stay was approximately 2 days shorter in infants who had a dorsal lumbar (25.7 hours) versus a flank incision (73 hours), and this difference did reach statistical significance. Hospital costs were less for the dorsal lumbar group but the difference was not statistically significant. Success and complication rates were similar between groups with 2 patients in each group requiring additional procedures.

Kumar and Smith<sup>21</sup> reached similar conclusions in their retrospective study based on 91 infants. Dorsal lumbotomy was claimed to be superior in that it required decreased hospital stay (3 versus 7 days), faster time to oral intake (48 vs 83 hours), preserved superiority of exposure and minimal learning curve.

Another controversy that surrounds pediatric pyeloplasty is whether trans anastomotic stents or nephrostomy tubes are required. Serdar Arda<sup>22</sup> et al published his results on trans anastomotic stents for dismembered in children. In all, 31 patients were included in his prospective, randomized clinical study of which 15 underwent a stented repair and the others non intubated repair. However, a perinephric drain was used in all the cases. Patients were evaluated in regard to the time of removal of the stent, duration of urine leakage, the duration of stay in the hospital in the post operative period and whether the outcome post operatively was favorable or unfavorable. The statistical analysis showed no significant difference in regard to the time of removal of the stent, the perinephric drain, duration of drainage, duration of hospitalization and the early or late complications between the two groups. Still, keeping the spectrum of cases in mind, the use of a stent is advisable in all patients with large pelvis with thin parenchyma for an effective postoperative drainage and stabilize the neo-anastomosis.

The debate regarding stented or stent less pyeloplasty in children has not settled yet. The points in favor of a stent include the risk of post operative urine leak and urinoma formation without a stent, solitary kidney, huge pelvis, inflamed tissues and after a difficult repair. However, those against stents take shield under the cover of risk of infection, the possibility of stricture due to the pressure of the stent over the anastomosis leading to local ischemia and pressure necrosis, the possibility of injury to the anastomosis or the renal tissue by accidental dislodgement of the device, prolonged hospital stay and restricted mobility of the patient. There exists a trend towards decreased complications and failures with the use of trans anastomotic stents and a suggestion<sup>23</sup> that tubes do not increase complications and even improve outcomes. Question arises what type of stent one prefers to use. The use of mallecot catheter as a nephrostomy should be discouraged as it causes significant morbidity, hematuria and even postoperative urinary fistula. Similarly, a feeding tube as a stent

should also not be preferred. This being pliable may break while stretching the same while removing in the postoperative period. Authors also donot use double J catheters in children as it requires second procedure under general anesthesia and it may not be feasible to accommodate them. Many of the patients might also disappear to come back only with complications eg. stone formation, infection. The stent also becomes brittle with the passage of time and may break while removing it endoscopically.

The authors' believe that most pyeloplasty cases should have the benefit of urinary drainage. The authors' preference remains for using a mini (3-4 cm long) transverse incision in the lumbar region, reaching the renal pelvis directly, decompressing the pelvis if the need be, identifying the PUJ and performing a reductionplasty, make an effective pelvi-ureteric anastomosis using fine interrupted sutures, use of a indigenized # 6 teflon stent ( with spatulated end and multiple holes in its terminal 5 cm length) across the pelvi-ureteric anastomosis serving as a nephrostomy as well as a stent. With this approach practiced since 1992 in over 300 cases, ( 1 month to 14), the long term results have been very encouraging, not even a single case requiring re-do surgery. The hospital stay had been short from 4-6 days. Hematuria, infection, postoperative fistula were seen in less than 5% patients.

### **Laparoscopic Assisted Pyeloplasty (LAP)**

Laparoscopic pyeloplasty<sup>57</sup> has been able to duplicate the high success rates achieved with open pyeloplasty, while offering advantages of minimally invasive techniques, minimal morbidity, shorter convalescence period and better cosmesis. Laparoscopic pyeloplasty can be performed in most patients with PUJ; however, experience in laparoscopy is required along with a vast repertoire of technical skill for an effective and purposeful procedure particularly when it comes to intracorporeal suturing. The specific indications for laparoscopic pyeloplasty include a failed retrograde or anterograde percutaneous endopyelotomy, anatomic abnormalities such as a horseshoe or pelvic kidney, presence of vessels at the PUJ, and an extremely dilated pelvis. The contraindications of a laparoscopic pyeloplasty are a small intrarenal pelvis, kidneys with poor function following a prolonged obstruction, and a failed open pyeloplasty.

Laparoscopic pyeloplasty was introduced in the adults in 1993 for the first time<sup>24</sup>. The initial 5 cases reported

took as long as 3 to 7 operating hours<sup>25</sup>. The procedure rapidly gained in popularity and the more recent series have reported a success rate of 95% (Ben Slama et al, 2000<sup>26</sup>). Laparoscopic pyeloplasty in children was first described by the transperitoneal route. Tan et al<sup>27</sup> reported the first series in children. 18 children aged 3 months to 15 years underwent transperitoneal dismembered pyeloplasty and the mean operative time was 89 minutes. Two patients had persistent obstruction and required repeat laparoscopic pyeloplasty.

Yeung and coworkers<sup>28</sup> in 2001 reported their experience in 13 patients. The procedure was performed by the retroperitoneal approach and the operating duration in their series varied from 103 to 235 minutes with a mean of 143 minutes.

Klingler et al<sup>29</sup> is credited with the prospective study aimed at comparison of open versus laparoscopic pyeloplasty techniques in treatment of uretero-pelvic junction obstruction which was published in the *European Journal of Urology* in 2003. Over a period of three years, the team performed 25 laparoscopic dismembering (LDP), 15 laparoscopic non-dismembering (LNDP) and 15 open dismembering pyeloplasties (ODP) in 55 patients. For laparoscopy two 12 mm and two 5mm ports were used, a ureteric stent remained in place for 4 weeks. ODP was performed via a flank incision, a percutaneous ureteric stent and a nephrostomy remained for 10 days. Postoperative morbidity was assessed by visual analogue scale (VAS). Mean follow-up was 23.4 months for laparoscopy vs. 21.9 months for open surgery. Success was evaluated with postoperative i.v. pyelogram or diuretic nephrography.

Postoperative VAS score was lower in the laparoscopic group (day 1: 3.5 vs. 5.4 day 5: 0.9 vs. 3.1,  $p=0.001$ ). Length of skin incision was 4.1 vs. 23.8 cm and hospital stay was 5.9 vs. 13.4 days for laparoscopy and ODP respectively. Success rate was 96.0% (24/25) for LDP, 73.3% (11/15) for LNDP and 93.4% (14/15) for ODP. Two patients with LNDP and one with ODP required re-operation. Clot retention was observed in two with LDP and one with ODP. Two abdominal wall herniations and one thrombo-embolism occurred with ODP. The overall conclusion was that dismembering laparoscopic pyeloplasty has the same success rates as open surgery but morbidity and complications are significantly decreased. Non-dismembering techniques have the least favorable results.

Special situations include hydronephrosis secondary to low UPJ, retrocaval ureter, horseshoe kidney, ectopic kidney, ureterocaliceal anastomosis, and redo

surgery. The retroperitoneal lateral approach provides the advantage of dealing with most situations requiring a pyeloplasty. Thus far, the only indications for performing a transperitoneal approach are the horseshoe kidney and the ectopic kidney.

To summarize the comparison between laparoscopic and open pyeloplasty

- The cosmetic outcome of laparoscopic pyeloplasty is superior to a conventional surgical incision. This point is more relevant to older children in whom the scar is more conspicuous by virtue of its position and more arguable in infants in whom the whole procedure can be accomplished through a small antero-lateral abdominal incision.
- LAP is associated with a small hospital stay
- LAP is associated with a reduced peri & post operative analgesia requirement
- LAP is associated with longer operating hours
- LAP is associated with all technical problems of laparoscopy and further exacerbated by the small size

### Robotic Assisted Pyeloplasty (RAP)

Robotics is an exciting and evolving area for minimally invasive surgery in children. Robotic pyeloplasty or what may be more appropriately addressed to as robotic assisted pyeloplasty in by far the commonest procedure making use of the da Vinci surgical system in the pediatric age group, the others include vesicourethral reflux correction, partial nephrectomy and nephrectomy.

The first robotic assisted pyeloplasty was done by Sung and colleagues<sup>30</sup>. The initial human series described the classical Anderson Hynes dismembered Pyeloplasty in nine patients using the daVinci robot<sup>31</sup>. Mean operative time was 138.8 min, mean suture time was 62.4 min, average blood loss was less than 50 mL in all the cases, and mean hospital stay was 4.7 days. One patient required open exploration and repair for a persistent renal pelvis defect after pyeloplasty. Follow up at three months was complete in five patients and all five revealed subjective and image proven improvement.

The largest series of completely robotic-assisted laparoscopic pyeloplasties with at least 11 months of follow-up was reported by Patel et al<sup>32</sup>. Fifty patients all underwent Anderson–Hynes dismembered pyeloplasty. Most patients were discharged on postoperative day 1. Ureteral stents were removed at three weeks.

**Fig 3: Surgical Outcomes and Complications of the Pediatric RAP series published to date**

Author	Number	Age (Range)	Operative time Minutes (Range)	Follow-up months (range)	Complication rate (N)	Complications (N)	Failure rate (N)	Failure cause (N)
Atug et al. (33)	7	()6-45) years	184 (165-204)	10.9 (2-18)	14.3% (1)	Prolonged drainage	0%	-
Yee Et al (34)	8	9.8 (6.0-15.6) years	248 (144-375)	14.7 (2-24)	0%	-	0%	-
Kutikov et al (35)	9	5.6 (2-8) months	122.8 (NA)	6 (NA)	0%	-	0%	-
Lee et al (36)	33	7.9 (0.2-19.6) years	219 (133-401)	10 (0.4-28)	3% (1)	Overlooked crossing vessel	3% (1)	Overlooked crossing vessel
(1) redo								
Olsen et al (37)	67		146 (93-300)	12.1 (0.9-17.9%) 49.1)		Conversion (1) Postoperative nephrostomy catheter (4) Hematuria (2) UTI (2) Displaced JJ – catheter (3)	6%	Overlooked crossing vessel (1) redo Kinking ureter (2) redo Re-stenosis (1) balloon dilatation

Patency of the UPJ was followed by diuretic renal scan at one month, then every three months in the first year, then every six months for the second year, and then yearly. There were no complications, and blood loss was minimal in all cases. Forty-eight of 50 (96%) patients had both objective and subjective improvement.

There are very few series reporting on RAP in the pediatric age group. The failure rate varies from 0 to 6%. No definite comments can be made about the post operative results of RAP because we still have to rely on the class IV evidence with no randomized controlled clinical trials. RAP provides

- Excellent three dimensional vision,
- Unprecedented control of endocorporeal instruments
- An ergonomic surgeon's position
- Decreased decreasing the length of the hospital stay and
- Reduced need for analgesia in the peri operative period.

However, it is accompanied with several shortcomings as well which include significant longer operating times and higher costs. However, operating times go down

with experience and become comparable to those of open procedures. The functional outcomes and the reported complications are same for the two groups.

No direct studies are as yet available to compare RAP with LAP in the pediatric age group. However, trying to extrapolate the adult data to this age group, one comes to the conclusion that there are no clear cut advantages of RAP over LAP for a trained and experienced laparoscopic surgeon in terms of operative outcomes, length of hospital stay, complications and operating times.

#### **Post Operative results following Endopyelotomy**

The principle of endopyelotomy has been taken from the concept of intubated ureterotomy given by Davis and Smart. Initially described for the adults, this technique is now being used for the pediatric patients as well. Endopyelotomy may be performed in either antegrade or retrograde fashion. The latter may be more problematic in younger children in that it carries an inherent risk of injury to the ureter. The incision could be made by electrocautery or by laser. Early results demonstrated that a cold knife incision is preferable to electrocautery in producing better healing and less scarring with less thermal injury<sup>38, 39, 40</sup>. Cold knife incision preserves ureteral blood flow with reduced tissue destruction.



The results of endopyelotomy by all approaches have been reported to be successful in 82% to 88% of patients<sup>41, 42, 43</sup>. Immediate success rates from endopyelotomy range from 57% to 100%. Long term patency is reportedly 64% to 85% after 37 to 60 months of follow up. The time to failure after endopyelotomy ranges from 10 to 20 months. Doo et al<sup>44</sup> demonstrated that the failure rate after endopyelotomy does not nadir until after 3 years of the procedure. Moreover, patients treated with endopyelotomy require longer follow up renal scintigraphy than after pyeloplasty.

Van Canh et al<sup>43</sup> followed up 102 patients who had undergone endopyelotomy for an average of 15 years and tried analyzing the reasons for success and failure in them. Long-term success was 75% with 13% late recurrences. Success in patients with crossing vessels at the UPJ was 42% with 31% failures. Success with hydronephrosis and a large renal pelvis was 81% with 4% failures. With hydronephrosis and a crossing vessel, success was only 39% with 39% failures, whereas absence of hydronephrosis and crossing vessel was associated with 95% success and no failure. Thus, patients with crossing vessels at the proximal ureter or redundant renal pelvis are less likely to have successful long-term results from endopyelotomy. In such cases, a preoperative workup with spiral CT scan becomes mandatory to rule out an aberrant vessel before considering endopyelotomy as the approach for the PUJ.

### **Post operative results following redo surgeries for Pelviureteric junction obstruction**

Development of a stricture after surgery is a difficult problem. The etiologies are multiple and include scarring, ureteral torsion, missed crossing vessels or a redundant pelvis. Simple nephrectomy has been considered in the setting of a normal contralateral kidney and the kidney in question being the seat of recurrent pain of infections. However, long term patency rates have been achieved for secondary PUJO as well. Therefore a salvage procedure should be considered the standard of care.

#### **A. Endoscopic Procedures**

Endopyelotomy and balloon dilatation are associated with low morbidity profile<sup>45, 46</sup> than pyeloplasty. Reported success rates with salvage antegrade endopyelotomy vary from 87.5 to 100%. However, the reported immediate failure is also very high. Possibly,

cases with stricture smaller than 1 cm and without too much of peri ureteral scar tissue are most likely to be successful.

#### **B. Redo Pyeloplasty**

A properly performed pyeloplasty has the potential of providing long term patency especially if the failure was due to an initially missed crossing vessel or redundant pelvis or ureteral torsion. Thomas et al<sup>47</sup> have reported success of 100% over an average follow up of 18 months. Braga et al<sup>45</sup> had similar results over an average follow up of 47 months.

#### **C. Ureterocalicostomy**

Ureterocalicostomy is commonly used as a salvage procedure after multiple failed reconstructions. The key to successful surgery is resection of the lower pole cleanly to expose a lower pole calyx. The ureter is resected until normal, vascular tissue is identified, widely spatulated and is sutured directly to the cut edge of the calyx with interrupted absorbable suture over a ureteral stent. Excellent success rates can be expected with a watertight, tense-free anastomosis<sup>48</sup>.

Matlaga BR et al<sup>48</sup> reported their contemporary experience with ureterocalicostomy to determine whether the indications or results have changed in modern practice. 11 patients aged 19 to 68 years (mean 38), underwent open surgical ureterocalicostomy. The indications for surgery were primary UPJ obstruction in 4, failed cutting balloon incision for UPJ obstruction in 3, proximal ureteral stricture after ureteroscopic stone removal in 2, and obliterated UPJ after percutaneous nephrolithotomy and failed antegrade endopyelotomy in 1 patient each. No patient experienced a significant peri operative complication. With follow-up ranging from 5 to 32 months (mean 10.1), relief of obstruction was evident in all patients as documented by intravenous urography or nuclear renography. Furthermore, the differential function on the involved side improved from a mean of 54.6% preoperatively to 60.1% postoperatively.

#### **Pelvi Ureteric Junction Obstruction in Children with Poor Renal Function**

The final aim of any treatment modality for PUJO is preservation of as much as renal tissue as possible. Undoubtedly, kidneys with no ability to recover function should be removed. The crux of the problem is that in the presence of obstruction, poor function documented

by renography cannot reliably predict the recoverability of useful renal function<sup>49, 50</sup>. The best evaluation of the capacity of a kidney to recover after obstruction is a period of therapeutic trial<sup>51</sup>, and PCN has been recommended for this purpose. A review of the available published reports suggests that around 50% of poorly functioning kidneys improve after a trial of PCN drainage. It has been documented in the study by Gupta DK et al<sup>52</sup> that the protocol to provide PCN drainage for around 4 weeks in patients with PUJO and a split renal function of less than 10% aids in differentiating kidneys that are likely to recover from those that are unlikely to recover renal function. Twelve of 17 kidneys with unilateral UPJO improved after PCN drainage and underwent pyeloplasty. The 5 kidneys that did not show improvement in the SRF, underwent nephrectomy. Patients with unilateral UPJO who improved after PCN drainage, the SRF increased to 29.2% +/- 12.6% and pyeloplasty was performed. At a mean follow-up of 2.3 years, none of these patients had developed hypertension, and the most recent SRF value was 31.4% +/- 12.8%. Heloury et al<sup>53</sup> also reported functional improvement in 6 of 11 poorly functioning UPJO kidneys. PCN is easy and safe even in small children<sup>51, 54, 55</sup>, and the rate of complications is low. The late sequelae of PCN<sup>56</sup> have been studied and shown to be minimal.

### Conclusions

Dismembered pyeloplasty is currently the gold standard for management of Pelviureteric junction obstruction. The procedure has stood the test of time, the long term patency rates are superior to that of any other modality, is technically feasible as a primary procedure as well as for redo cases, if performed well by the experienced personnel, is free from major complications most of the time and is feasible via open surgery, laparoscopically or even with robotic assistance. Refinements include, choosing a smaller incision, draining the kidney with a smaller sized stent, performing a meticulous pelvi-ureteric anastomosis and preventing the postoperative complications.

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