SCIENTIFIC ARTICLE

Management of ureteropelvic junction obstruction in an era of minimally invasive surgery

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Introduction

Ureteropelvic junction obstruction (UPJO) is defined as a significant impairment of the drainage of urine from the renal pelvis to the proximal ureter. If not detected early and treated promptly this condition could result in persistence of symptoms spanning from recurrent urinary tract infections (UTI), urolithiasis and eventually complete loss of the affected kidney. UPJO is the most common cause of upper renal tract congenital anomaly. The reported incidence of UPJO may be as high as 1 in 1500 live births evident at routine antenatal ultrasound scan, however not all cases (in fact less than 10%) require surgical intervention.[1] The exact incidence of UPJO is less well-defined in adult population. It is seen more frequently in boys, with up to twice the number of reported cases being males. The left side is affected twice as often as the right side [2].

The aetiology of UPJO can be both congenital and acquired. Congenital causes thus far are more frequent. The primary cause of congenital UPJO is a functional obstruction as a result of ureteral hypoplasia or high insertion of ureter resulting in mechanical obstruction or due to entrapment of the ureter by crossing vessel [1]. An abnormal arrangement of smooth muscles in the UPJ is seen in ureteral hypoplasia. However in majority of cases the ureter is inserted into the most dependent part of the renal pelvis. But when the ureter is inserted high in the pelvis it may cause an acute angulation interrupting the free flow of urine.

Entrapment of the ureter may occur due to crossing of renal vessels, most commonly from an accessary renal artery or a large branching of a lower polar artery resulting in kinking of the proximal ureter and interruption of the free flow of urine. Acquired causes of UPJO may be either extrinsic causes such as retroperitoneal fibrosis, abdominal lymphadenopathy or intrinsic causes such as chronic inflammation due to impacted stones or ureteric tumour.

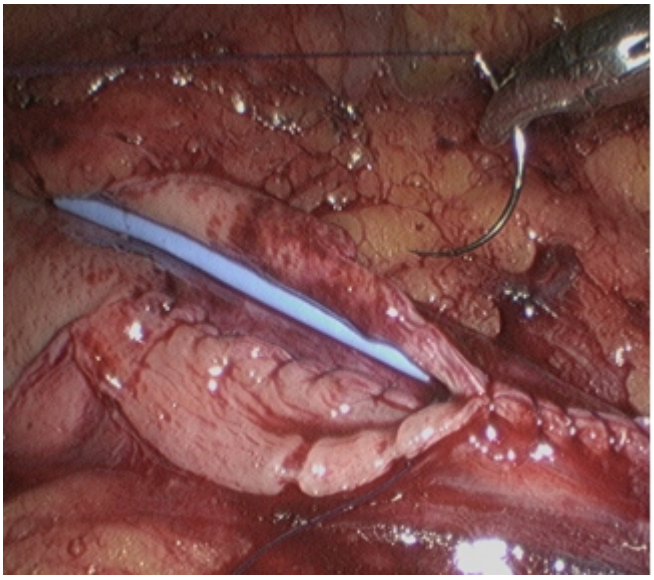

Figure 1. Laparoscopic pyeloplasty in progress with a double J stent in situ

The most successful treatment option for this condition is surgery, which involves excision of the diseased segment and reconstruction of redundant renal pelvis in to a funnel. The first open surgical procedure for UPJO was performed by Trendelenburg in 1886. Shortly afterwards, Fenger found the application of the Heineke–Mickulicz principle. His main application was to create a larger luminal diameter at the UPJO to avoid development of strictures. Various other techniques also evolved over the years. The more common ones being Foley Y-V plasty, Culp and de Weed spiral flap and the Scardino vertical flap [3]. However, the gold standard technique remains dismembered pyeloplasty which was described by Anderson and Hynes in 1951, which is open surgery through a flank incision [4].

In the latter part of 20th century percutaneous and endo-urological techniques emerged for the treatment of UPJO. Endopyelotomy is a technique developed based on a full-thickness lateral incision of the stricture using laser or cold knife. This principle was described earlier by Albarran.[5] Following the procedure, a stent is placed for some time as

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described earlier by Davis in 1943 as a post procedure step. On the other hand endopyeloplasty being a percutaneous technique incorporates the "Fenger-plasty" principle where laparoscopic shears and suturing devices are employed to treat UPJO [6].

Towards the end of the 20th century laparoscopic pyeloplasty become increasingly popular ((Figure 1). Regardless of whichever technique is employed, sound surgical judgment of the aetiology and proper reconstruction of the diseased segment is the critical factor affecting the long-term outcome. The aim of this study was to assess the patients presenting with significant primary UPJO and their outcomes following minimally invasive surgery.

Material and method

Retrospective data were collected and analyzed from March 2014 to December 2020, on a total of 52 patients presenting with evidence of congenital UPJO with significant hydronephrosis. After a detailed history and examination, all patients underwent a CT urogram followed by a Diethylenetriamine Pentaacetic Acid (DTPA) renal scan when indicated.

Patients who were symptomatic and found to have poor renal function evident by less than 5 mm cortical thickness in all three poles in the CT urogram and/or on DTPA scan showing split renal function (SRF) less than 15%, underwent nephrectomy. Patients with recurrence of UPJO with short strictures, underwent laser endopyelotomy while those with long strictures underwent redo-pyeloplasty. Patient who underwent open pyeloplasty were excluded from the analysis. All others who underwent standard Laparoscopic Pyeloplasty (LP) were further evaluated.

Demographically age and gender were noted. Clinical data evaluated included laterality, presentation, operative time and length of hospital stay. Following the surgery improvement of symptoms, renal function and degree of hydronephrosis were assessed. Surgical complications were classified according to the Clavien-Dindo classification.

Patients for laparoscopic pyeloplasty were placed in a lateral decubitus position following general anaesthesia. A 4-port entry technique was employed (two each 10mm and 5 mm trocar). Following a transperitoneal approach the ipsilateral colon was reflected to identify the dilated renal pelvis and the proximal ureter.

The cause of UPJO such as intrinsic stenosis or crossing vessels were identified. Laparoscopically proximal ureter and the renal pelvis were fully mobilized. Depending on the size of the renal pelvis, ureteric insertion and the aetiology, the reconstruction technique was tailored. In the presence of an aberrant vessel the renal pelvis was dismembered with the proximal ureter. The stenotic segment was excised and the ureteric end was spatulated. The enlarged renal pelvis was resected to reduce the size of the pelvis and to improve the urinary drainage as in classical Anderson–Hynes technique. The ureter and the renal pelvis was transposed ventrally to the vessels for complete the anastomosis. When an aberrant vessel was absent a Flap plasty, Y-V plasty (Figure 1) or Fengerplasty was done as required.

In cases of calculi in the pelvic calyceal system, the stones were removed by using laparoscopic grasping forceps. When difficulty was encountered a Flexible cystoscope was introduced through a laparoscopic port in to the renal pelvis and directed towards the stone. The anastomosis was performed using 4/0 PDS or vicryl over a 6F double J stent which was inserted in an antegrade manner. A non-suction drain was selectively placed through the lateral port incision into the perinephric space adjacent to the UPJ. Port sites were closed in a standard manner.

Catheter was removed on day 5 to 7. The stent was removed at 8 to 12 weeks. Follow-up studies were performed with an evaluation for symptom improvement, renal ultrasound and DTPA scan at six months or beyond. Subjective success was considered when there was an improvement of the symptoms. Objective success was considered when evident in an improved DTPA scan. CT urogram was performed when DTPA scan failed to demonstrate a satisfactory improvement. Recurrent UPJO was dealt by laser endopyelolotomy.

Results

Overall, 52 patients with UPJO were enrolled to the study. Eight patients who were symptomatic with SRF <15% on DTPA renal scan with thin parenchymal tissue on CT scan underwent laparoscopic nephrectomy. Two peadiatric patients (age 7 and 9 years) underwent open surgery due to the unavailability of peadiatric laparoscopic instrumentation. In addition, two other patients who had open surgery during childhood underwent laser endopyelotomy. Therefore, excluding those 12 patients, the rest (n=40) underwent standard LP (Table 1).

There was a slight male preponderance with mean age of 32 years. The mean BMI was 24.7 kg m-2. Majority (75%) of the patients were ASA II where 5 (12.5%) patients were CKD stage II. Thirty-three (82.5%) patients were symptomatic with loin pain and/or recurrent urinary tract infections. All patients had a primary UPJO and a significant hydronephrosis with an enlarged renal pelvis. Based on the DTPA renal scan, all had O'Reilly type B curve while SRF <40% was reported in 22(55%) patients.

Right and left sided UPJO were present in 21 and 19 patients,

Table 1. Clinical profile of patients with UPJO

Characteristics		Category	No (range)
Total No of patients			40
Gender		Male	22 (55%)
		Female	18 (45%)
Age (years)			32 (17 - 61)
BMI (kg m^{-2})			24.7 (14.6 – 37.7)
Comorbidities		Renal impairment	5
		Hypertension	9
		Diabetes mellitus	4
		Bronchial asthma	3
		Others	8
Presentation		Imaging detected	7
		Pain	23
		Urinary tract infections	10
Imaging findings	Hydronephrosis of	Solitary kidney	1
		Unilateral kidney	37
		Horse shoe kidney	1
		Lower moiety of a duplex kidney	1
	Other findings	Associate stones	7
		Aberrant vessels	11
	DTPA	$T_{1/2}$ > 20 min	40 (100%)
		SRF < 40%	22 (55%)

Table 2. Outcome following LP

Side	Left LP	19 (47.5%)
	Right LP	21 (52.5%)
Type of surgery		
	Anderson-Hynes	13 (32.5%)
	V-Y plasty	4 (10%)
	Flap technique	22 (55%)
	Fenger	1 (2.5%)
Conversion to open		0
Mean operation time (min)		176 (120-280)
Mean hospital stay (days)		3.5 (2-9)
Complications	Overall	15 (35.5%)
Early (<6 months)	Prolonged drain	2
	Recurrent UTI	7
	Anuria	1
	Port site infection	2
Late complications	Recurrent UTI	3
	Stricture	2
Outcome	Success rate	35 (87.5%)
	Laser Endopyelotomy	2

Table 3. Comparison data with similar studies

	Rass weiler[16]	Moon[17]	Lopez-Pujals[18]	Jarrett[14]	Klingler[19]	Turk[20]	Present study
Patients	143	170	47	100	40	49	40
Approach	RP	RP	TP	RP	TP	TP	TP
Mean op. time (min)	125 (37-368)	140 (58-290)	340 (200-717)	260	NA	165 (90-140)	176 (120-280)
Mean hospital stay (days)	5 (3-10)	3 (2-14)	2 (1-3)	3.3	5.9	3.7 (3-6)	3.5 (2-9)
Complications	6.3%	7.1%	6.4%	12%	2.5%: Stricture 2.5%: Urinoma	2%: Leak	5%: Leak 5%: Stricture
Conversion to open	0.7%	0.6%	2.1%	0	5%	N/A	0
Mean follow up time (months)	63 (3-137)	12	19 (2-55)	11.7	23 (6-42)	23 (1-53)	22 (7-81)
Success	94.4%	96.2%	93.6%	96%	87.5%	98%	87.5%

RP: Retroperitoneal **TP:** Transperitoneal

respectively. There were three occasions where the surgery was technically challenging which included a LP done for a solitary kidney patient, horseshoe kidney and on a lower moiety of a duplex kidney.

Thirteen (32.5%) patients underwent Anderson-Hyens technique where as a crossing lower polar vessel was encountered in 11(27.5%) patients. But in the majority the flap techniques were undertaken where the redundant pelvis was used to widen the UPJ similar to a rotational flap. Seven patients who had renal stones underwent stone extraction. Flexible cystoscopy through the 10 mm port was used to facilitate the stone extraction in difficult cases. (Table 2)

All operations were completed laparoscopically. The mean operative time was 176 min (range 120–280 min). There was no conversión to open surgery. Blood loss was negligible and there was no need for any transfusions despite surgery being done on CKD patients with low baseline haemoglobin levels. Mean post-operative hospital stay was 3.5 days (range 2–9 days). The Foley catheter was removed after 5 to 7 days except in 2 patients and the stents were removed after 8 to12 weeks in the majority.

Overall there were 15(37.5%) complications according to the clavien dindo classification. Majority (30%) were minor complications. Recurrent or persistent UTI was settled with antibiotics and removal of ureteric stent prematurely. Two patients who had prolong drain, of which one was a nephrotic syndrome patient, were managed conservatively with fluid restriction and prolong catheterization. Two other patients develop port site infections and were managed with oral antibiotics. One patient with a solitary kidney developed anuria soon after stent removal. Immediate ureteroscopy revealed the endo button of the suture had migrated down the ureter which was obstructing the lumen. Dormia basket extraction of the button and restenting was done after which he recovered completely.

The mean follow-up was 22 months (range 7 - 81 months). The overall success was 87.5% where all patients who had pain showed a marked improvement of their symptoms. SRF >5% improvement was seen in 11(27.5%) patients while functions remained stable in 27(67.5%) patients. Two patients who had further deterioration of the renal functions were managed with laser endopyelotomy. However, 3 other patients developed recurrent UTIs despite stable renal function, are managed conservatively up to now.

Discussion

UPJO is the commonest congenital abnormality encountered in the ureter. Although the problem is congenital, the clinical presentation occurs late in life. In adults, intermittent abdominal or flank pain which worsens during brisk diuresis (Dietl's crisis) is often the presenting complaint. However some may present with abdominal mass, nausea, vomiting or haematuria following minor trauma. Rarely patients will present with an infection resulting in pyonephrosis. In others, it is an incidental finding following modern imaging [7].

The main aim of investigations is to diagnose the degree and site of obstruction in order to plan treatment options. Diuetric renography using Tc 99m (DTPA) is the commonly used diagnostic tool which shows a type B curve according to O'Reilly [8]. Normally, the time required for the clearance of 50% of the accumulated radionuclide (t1/2) is less than 10 min, while t1/2 of more than 20 min is suggestive of a significant obstruction. Also, DTPA has the added advantage of measuring the glomerular filtration rate. However, MAG3 is the radiopharmaceutical agent of choice for this purpose replacing DTPA in the current era. It provides a better gamma image with low background activity with faster clearance than DTPA. Unfortunately, the cost as well as its availability has been the limiting factor for its frequent use in Sri Lanka. On the other hand, CT or MRI has the added advantage of providing a detailed anatomy of the pelvis and ureter also the presences of aberrant hilar vascular anatomy.

The main aim of treatment is to achieve relief from symptoms and to prevent deterioration of renal function. The indications for surgical intervention include pain associated with infection/stone formation, asymptomatic obstruction with SRF<40%, more than 10% deterioration in SRF during the follow up and grade 3 or 4 renal pelvic dilatations on imaging.[9] However if SRF <15 - 20%, with enlarged renal pelvic diameter (AP length more than 50mm) on imaging, pyeloplasty will not have a significant impact on the UPJO. Therefore, in such instances patients undergo nephrectomy for symptom relief, as in our series.

Over the last century, the surgical options for UPJO has been pyeloplasty, endopyelotomy, endopyeloplasty and nephrectomy. Open pyeloplasty was performed through a lumbotomy or supracostal lateral wall incision. The success rate was >90%, and the procedure has stood the test of time.

The first published laparoscopic pyeloplasty cases date back to 1993, as reported by Schuessler and colleagues [10]. Laparoscopic pyeloplasty, a minimally invasive surgery replicating each step of open surgery provides excellent success rates. The main advantage is avoiding a large and arguably more painful flank incision which may lead to a “flank bulge” due to denervation of muscles which can be prevented. Therefore, laparoscopy provide an added advantage of decreased analgesics requirement, shorter hospital stay, early return to activity and better cosmesis

compared to open surgery.[11]

Both trans-peritoneal and retroperitoneal approaches may be employed in performing laparoscopic pyeloplasty. The preferred approach is usually decided by the surgeon. But many urologists prefer a the transperitoneal approach as it gives a distinct advantage of increased working space and more familiar anatomy as was in our case series.

The pyeloplasty technique may vary. The indication for each technique are identical to that with open surgery. Anderson-Hynes remains as the most popular technique. However other techniques also have shown similar outcomes. Laparoscopic pyeloplasty was not adopted initially due to the technical demand of intracorporeal suturing which is difficult to master to the novice surgeon. Despite the development of easy anastomotic techniques such as endostitch, laser welding and technology such as robotics, surgeons from low middle income countries such as ours do not have access to them. Therefore, it is important to master intracorporeal suturing technique and rely on less expensive suture methods.[12] This lead to longer operative times initially until the surgeon had mastered the technique of intracorporeal suturing.

Table 3 summarizes literature on laparoscopic pyeloplasty including those series of more than 40 patients who were evaluated based on the renograms. Although the reported success rate is above 87% in all these studies, there seems to be no standardized assessment of the outcome. The actual success of therapy therefore should be a measure of the relief of symptoms, increase in SRF >5%, and improvement of renogram pattern at one year follow up.[13] Although long-term follow up data is sparse; generally, failures following laparoscopic pyeloplasty tend to occur within the first year. The average time to failure is around 3 to 11 months (mean =4.6 month).[14] Recurrence following laparoscopic UPJO is around 2 to 5%. The main causes for recurrence are severe peripelvic and periureteric fibrosis due to urine leak, ureteral ischaemia due to extensive dissection, inadequate haemostasis and failing to diagnose lower pole crossing vessels. These patients would require a redo-pyeloplasty, endopyelotomy or ureterocalicostomy. Other common complication included infection and pyelonephritis which can be treated conservatively as in the present study. The overall reported incidence of conversion to open surgery was 0 to 6.4%. Though enodopyelotomy is a less invasive technique its success is 80%. This is best suited for short strictures less than 1.5cm. The ureteric stent must be left in-situ for at least for 8 weeks. Therefore, this procedure is reserved for patients with recurrence after pyeloplasty and for elderly patients.[15,16]

Endopyeloplasty is a rarely used technique where a percutaneous tract made. Using a 26F nephroscope, a standard vertical incision is made and horizontal suturing is done. In the present day it is rarely used, as it does not provide a definitive treatment.

Nephrectomy is indicated for missed UPJO with poorly functioning kidney which are symptomatic. If an accessory crossing vessels if found during nephrectomy there is heightened concern of a contralateral crossing vessel of the remaining kidney. Thus, close follow-up of the opposite kidney with ultrasonography is recommended.

Laparoscopic pyeloplasty along with robotic pyeloplasty have gained popularity globally. These minimally invasive techniques have now become the surgical treatment of choice for UPJO. As this laparoscopic technology is still in its infancy in many centers in Sri Lanka, the number of patients in this series also remains small. With the development and advent of new laparoscopic urology centers in the country, we are likely to witness their incorporation as standard care for UPJO, resulting in better patient outcomes.

All authors disclose no conflict of interest. The study was conducted in accordance with the ethical standards of the relevant institutional or national ethics committee and the Helsinki Declaration of 1975, as revised in 2000.

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