

Laparoscopic pyeloplasty: the first decade

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INTRODUCTION

The optimum surgical correction of PUJ obstruction (PUJO) has been a urological challenge for well over a century. Open pyeloplasty, originally described by Andersen and Hynes [1], remains the standard against which any new techniques must be compared. The success rate of open pyeloplasty, even over the long-term, is >90% [2]. In 1983 Wickham and Kellet [3] described percutaneous pyelolysis (endopyelotomy), which subsequently gained some popularity. Several other procedures have been described, including retrograde endopyelotomy, the Acusize® and balloon dilatation. The success rates of all these minimally invasive options have consistently been less than with open pyeloplasty by 10–30%.

Laparoscopic pyeloplasty (LP) was introduced in 1993 by Schuessler *et al.* [4] and has developed worldwide as the first minimally invasive option to match the success rates of open pyeloplasty, while achieving the added goals of low morbidity, short hospital stay and convalescence. Herein, we review the current status of LP.

TECHNICAL CONSIDERATIONS

LP can be performed by either the trans- or retroperitoneal route, with the primary determinant being the surgeon's preference and experience. Although a dismembered Andersen-Hynes pyeloplasty is preferred, dismembered flap pyeloplasty and a variety of non-dismembered procedures, including Y-V plasty, flap pyeloplasty (Culp) and Fengerplasty, have also been described.

Briefly, the anaesthetized patient is placed in a lateral position and three or four

ports introduced to enable dissection and identification of the PUJ. The technical principles and goals are similar to those of open surgery. Depending on the type of procedure the PUJ is either incised or dismembered, and reductive pyeloplasty performed if indicated. The ureteric JJ stent is typically inserted retrogradely before (the authors' preference being 4.7 F, 26 cm) or during surgery. A drain is inserted to lie adjacent to the completed repair and a Foley catheter is left in the bladder.

Patients typically commence free oral intake of fluids 8–12 h after surgery; the urethral catheter is removed after 1–2 days and the wound drain subsequently. The ureteric stent is typically removed by outpatient flexible cystoscopy at 4 weeks, after IVU.

RESULTS

The results of LP are shown in Table 1 [4–7,8–10]; several early reports were excluded where updated results from the same institution were published more recently. Several points are worth specific comment. The success rates of LP are consistently high, at 87–98%; the rates are >95% in series with a predominance of primary procedures, with only one exception. The 'success rate' is defined as the objective radiological success, i.e. with a patent and unobstructed PUJ (or an improvement in drainage) by either IVU or diuretic renography. Subjective improvement rates, e.g. from patient questionnaires, are invariably less than the radiological success rates by 10–30% for both open and endourological pyeloplasty. There are several possible reasons for this discrepancy, but the present discussion focuses on the objective radiological success rate, which is reported rather more consistently.

Most published series of LP have used the classic Andersen-Hynes technique, reflecting the attempt to duplicate the well-established principles of open surgery. The delicate dissection and tailoring of the PUJ and precise

sutured anastomosis created is facilitated by the clear and magnified view provided by laparoscopy.

The prolonged operative duration of reconstructive laparoscopy is significant, but there has been a trend towards a reduction, from a mean of 330 min in the original series to 164–252 min in contemporary series reported in the last 3 years [6–9,11]. This reflects increased confidence and ability in intracorporeal suturing and knot-tying. Laparoscopic suturing and knot-tying can be learned effectively and reinforced by regular repetition in a 'dry lab' environment. The effect of increasing experience is notable, with an experienced laparoscopist consistently performing the entire procedure (transperitoneal) in <3.5 h [9]. The retroperitoneal approach (mean operative duration 175 min) is seemingly quicker than the transperitoneal approach (mean 246 min) in contemporary series reported since 2001. This is probably because it takes less time to dissect and identify the PUJ with the retroperitoneal technique. The low morbidity of LP is well reflected in the low incidence of complications during and after surgery even in the initial series. The risks of blood transfusion are remarkably low, being limited to anecdotal reports, in sharp contradistinction to endopyelotomy, where the transfusion rates are 3–11%. The hospital stay is short, averaging 3.8 days in the series reported since 2000.

To our knowledge there has been at least one abortive attempt to compare laparoscopic with open pyeloplasty in a prospective randomized trial [8]. The failure was principally because the patients were unwilling to submit to randomization between techniques with such differing levels of perceived invasiveness. In a retrospective study by Bauer *et al.* [12], 42 LPs were compared with 35 open pyeloplasties over a similar period. Pain relief (38/42, 90% vs 32/35, 91%), relief of obstruction (41, 98% vs 33, 94%) and improved activity levels were equivalent in both groups. Soulie *et al.* [13]

TABLE 1 Series of LP from 1993 to 2003; only series with >20 patients are included, except for the pioneering series by Schuessler *et al.* [4]

Variable	Study						
	[4]	[5]	[6]	[7]	[8]	[9]	[10]
No. of:							
pyeloplasties	5	67	50	55	49	100	36
A-H pyeloplasties, n (%)	5	0	50 (100)	48 (87)	49 (100)	71 (71)	31 (86)
Surgical approach	Trans	Trans	Retro	Retro	Trans	Trans	Trans
Mean (range):							
op. duration, min	330 (210–240)	119 (90–210)	164 (120–240)	185 (100–260)	165 (90–240)	252 (120–480)	372 (162–600)
2ry pyeloplasties, n (%)	0	NA	4 (8)	1 (2)	0	17 (17)	36 (100)
Complications:							
during	–	–	–	–	–	2 (2)	1 (3)
after	1	1 (2)	2 (4)	7 (13)	1 (2)	11 (11)	8 (22)
Conversion, %	0	1 (2)	2 (4)	3 (5)	0	0	1 (3)
Mean (range):							
hospital stay, days	12 (9–17)	4.1 (2–7)	2.6 (2–7)	4.5 (1–14)	3.7 (3–6)	3.3 (2–8)	2.9 (1–7)
follow-up, months	12 (9–17)	25 (4–60)	19 (3–72)	14 (6–44)	23 (1–53)	26 (12–72)	10 (3–40)
Success rate, n (%)	4/5	66 (99)	49 (98)	48 (87)	48 (98)	96 (96)	32 (89)

A-H, Andersen-Hynes; NA, not available.

drew similar conclusions in a study of 53 consecutive unrandomized patients; 26 LPs (retroperitoneal) were compared with 28 open pyeloplasties through a 'mini' incision. The incidence of complications after surgery (12% vs 14%), hospital stay (4.5 vs 5.5 days) and radiological success (89% vs 89%) were equivalent in both groups. Return to painless activity was more rapid with LP in younger patients. The operative duration was only slightly longer with LP (165 vs 145 min).

LP FOR SECONDARY (RECURRENT) PUJO

LP has been used in patients in whom previous endoscopic and/or open pyeloplasty had failed. The first report was published in 1995 and updated in 2003 [10]. Thirty-six patients with a mean (range) of 1.3 (1–4) previous procedures were offered LP; 32 (89%) had a successful outcome, with a patent unobstructed PUJ on objective radiological tests. Two patients had equivocal drainage on renography but were asymptomatic and had a detectable improvement in drainage characteristics, giving an overall success rate of 94%. Notable points included the longer mean (range) operative duration of 6.3 (2.7–10) h; the mean follow-up was 21.8 (3–85) months. Jarrett *et al.* [9] reported similar results in a subset of 17 patients having secondary LPs in their series, and success was reported for 15 patients. Siqueria *et al.* [11] also reported success in eight of nine patients.

CROSSING VESSELS

The contribution of crossing vessels to the functional obstruction of the PUJ is an area of controversy and a few points are pertinent. First, there is a higher incidence of crossing vessels, as detected by colour Doppler ultrasonography, in relation to kidneys with known PUJO (79%) than in kidneys with no evidence of PUJO (35%) [5]. Sampaio [14] showed that the incidence of anterior (ventral) crossing vessels in an anatomical cadaveric study of 546 kidneys was 65%. Second, crossing vessels are commoner in adult kidneys (50–80%) with PUJO than in paediatric kidneys with PUJO (30%), and absent in prenatally detected PUJO [15]. These interesting observations of the natural history might reflect a time-dependent relation between the development of adult PUJO and the frequently adjacent crossing vessel. Third, the negative association between the presence of a crossing vessel and the success rate of endopyelotomy was described by Van Cangh *et al.* [16]. In that study the long-term results of endopyelotomy were reviewed in a series of 102 consecutive patients. At a mean follow-up of 5 years, the success rate of endopyelotomy in the presence of crossing vessels and high-grade hydronephrosis was 39%, compared with 95% when these factors were absent.

It appears reasonable therefore to conclude that crossing vessels are an important

consideration in managing PUJO, even though the relative contribution of crossing vessels to the pathophysiology of the individual PUJO will probably always be difficult to quantify, as there are subtle differences in vessel size, distance from and relation to the PUJ, degree of hydronephrosis, level of kidney function and the presence of peri-ureteric and perivascular bands and adhesions.

An interesting point about LP is that thus far there is no apparent difference in the success rate of transperitoneal or retroperitoneal LP (Table 1). Eden *et al.* [6], in their large retroperitoneal series, reported only 21 of 50 (42%) crossing vessels adjacent to the PUJ, i.e. lower than in most transperitoneal series. Only in 15 of these was the ureter transposed; despite this the success rate was high, at 98%.

The high success rate of open and LP appears to be related more to the precise sutured reconstruction of the PUJ than the presence or absence of crossing vessels. It is intuitive that the laparoscopist using the transperitoneal route would have a greater need for anterior PUJ transposition in a dismembered pyeloplasty with crossing vessels, both to adhere to cherished traditional principles and probably more importantly, to make visualization and performance of the repair technically feasible. The retroperitoneal laparoscopist would similarly be more likely to not transpose the anterior crossing vessel, arguing that the

ureter is lying naturally and anatomically as the most posterior structure in the retroperitoneum. Our view is that the precise plastic repair of the PUJ is most important for the success rate of pyeloplasty with the crossing vessel either transposed or translocated cephalad from the PUJ area, as per the individual case. This view is reinforced by the results of Janetschek *et al.* [5], where it appears that successful LPs can be achieved if any crossing vessel is moved superiorly away from the newly repaired PUJ.

LP AND CONCOMITANT PYELOLITHOTOMY

The presence of calculi is not a contraindication to LP; Ramakumar *et al.* [17] reported a series of 20 concomitant LPs with simultaneous laparoscopic stone extraction. This can be done by using grasping forceps or with the aid of a flexible cystoscope passed down a 10–12 mm port. At the 3-month follow-up 18 patients were stone-free and the LP was successful in 18.

LP IN CHILDREN

The retro- and transperitoneal approach were reported to have good success rates, ranging from 12 of 13 [18] to 14 of 16 [19], respectively. Age or patient size does not appear to be a significant hindrance, as children as young as 3 months have had successful procedures.

ANATOMICAL VARIANTS

LP has been reported for PUJO in the presence of a horseshoe kidney [5]. The anterior location of the PUJ may facilitate the laparoscopic approach, although care must be taken to identify and preserve any aberrant renal vessels.

PERCUTANEOUS ENDOPYELOPLASTY

A novel technique for the endourological management of primary PUJO was recently described by Gill *et al.* [20] Percutaneous endopyeloplasty combines established endourological techniques with modified laparoscopic techniques for the intrarenal transverse suture repair of a longitudinal endopyelotomy incision of the PUJ through a solitary percutaneous nephrostomy tract. The initial report described nine successful procedures in carefully selected patients. The mean (range) operative duration was 101 (62–140) min.

ROBOTIC PYELOPLASTY

Since the initial introduction of robotics in 1991 there have been numerous reports of its application in nearly all surgical specialties. The goal of advanced robotic systems is improved operative technique and simplified suturing. Initial reports of robotic LP in pigs were published by Sung *et al.* [21] and in humans by Gettman *et al.* [22]. While these initial reports show the feasibility of robotic LP several limitations remain. These include cost, limited instrumentation, the need for experienced table-side laparoscopic assistance, and the current lack of long-term data.

CONCLUSIONS

The benefits of LP include the high and reproducible success rates in reported series thus far, comparable with the results achieved by open pyeloplasty and better than the other currently used endourological minimally invasive options. LP achieves a technically sound operation using well-established principles familiar to urologists, and it is cosmetically superior to open pyeloplasty. The varied surgical anatomy of the PUJ (huge dilatation, crossing vessels, high insertion of ureter to pelvis), which has been shown to compromise the results of other endourological procedures such as endopyelotomy, is not a limiting factor in LP. Results to date indicate minimal levels of morbidity, a short hospital stay and a quick return to normal activities. The disadvantages include the somewhat longer operative duration and significant issues about training and experience in advanced urological laparoscopy.

After a decade it appears that LP is here to stay and represents an emerging standard of care. In the present era of Internet access to up-to-date, real-time information, patients are increasingly likely to ask about LP.

CONFLICT OF INTEREST

None declared.

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- Abbreviations:** LP, laparoscopic pyeloplasty; PUJO, PUJ obstruction.