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Risk Factors and Management Options for the Adult Failed Ureteropelvic Junction Obstruction Repair in the Era of Minimally Invasive and Robotic Approaches: A Comprehensive Literature Review

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Abstract

Guidelines for the management of pyeloplasty failure remain elusive given the rarity of this condition and the difficulty of integrating and analyzing reported outcomes given the varying definition of failures. In this article, we aim to review the existing literature on risk factors that may influence the surgical outcomes of reconstructive pyeloplasty for ureteropelvic junction obstruction. Furthermore, we discuss management options and review success outcomes of treatment options for patients with pyeloplasty failure.

Keywords: pyeloplasty failure, salvage pyeloplasty, ureteropelvic junction obstruction, ureteral reconstruction

Introduction

Ureteropelvic junction obstruction (UPJO) is a condition that describes the failure of antegrade urine flow from the renal pelvis into the ureter due to an extrinsic or intrinsic obstruction. While this is most commonly the consequence of a congenital obstruction, it can clinically manifest at any time of life, and the diagnosis is often times not apparent until adulthood.[1] Initial symptoms present as intermittent abdominal or flank pain of the affected side in association with nausea or emesis. More often than not, this diagnosis is made incidentally on radiographic imaging in the absence of symptoms.

Surgical intervention is seldom required if the patient remains asymptomatic and if the obstruction does not progress to renal function deterioration. In such patients, close observation with serial renal scans is an appropriate management option. Patient adherence through the observation period is key, as one third of patients who undergo surveillance will require surgery within 4 years.[2]

The pyeloplasty is the industry's gold standard for treatment of UPJO when surgery is indicated. While there are multiple techniques to perform a pyeloplasty, all techniques share similar treatment goals: preservation of renal function, alleviation of pain, removal of stones, and prevention of recurrent infections. The refinement of this procedure using minimally invasive techniques has brought the modern success range from 90% to 100%.[3–5]

That being said, we have not reached perfection with our surgical outcomes and the prevalence of pyeloplasty failure can be as high as 10% in the hands of experienced surgeons.[3–5] Pyeloplasty can fail due to surgical technical error or due to ischemia of the urothelial anastomosis, which results in stricture formation, with most failures occurring in the first 2 years after the surgery.[6]

A comprehensive review of pyeloplasty failures and its management is lacking in the literature. In this article, we query the existing literature on risk factors thought to be associated with pyeloplasty failures as well as summarize management options for those who have failed a prior pyeloplasty. A review of the literature was conducted by search of the National Library of Medicine (PubMed) in the English language using the search terminology ''adult + pyeloplasty + failure'' from January 1980 to present. Additional references were culled from the reference list of the included studies.

Potential Risk Factors for Pyeloplasty Failure

In the first section of our review, we present potential risk factors associated with surgical failures in patients who have undergone pyeloplasty. We identify several patient and surgical factors that have been investigated in the medical literature as predictors of pyeloplasty failure, including poor preoperative split renal function (SRF), patient age, early urine leak, presence of renal stones, and abnormal renal histology. We will now review each of these factors and reference supporting data.

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Preoperative SRF

Early studies investigating preoperative SRF in the pediatric population found inconclusive evidence of its relationship to pyeloplasty failures.[7,8] In the adult population, nuclear medicine testing suggests higher surgical success with pyeloplasty for preoperative SRF greater than 30%. Patients with a preoperative SRF ≥30% had a 50% chance of improved renal function after the surgery, compared with only 20% improvement in patients with SRF <30%.[9] In contrast, a large retrospective study of 138 patients did not find preoperative SRF to be an independent predictor of recoverable postoperative renal function based on postsurgical renal scan at 6 months following Anderson–Hynes dismembered pyeloplasty.[10] In light of these conflicting findings, a comprehensive analysis of pyeloplasty failures is limited as both studies omitted failure endpoints such as subjective resolution of symptoms or a need for a repeat procedure(s), both of which are pivotal endpoints in outcome measurement.[9,10]

Preoperative SRF was also investigated by Grimsby and colleagues in a cohort of patients who had undergone robotic pyeloplasty.[11] This study is unique in that it provided an updated analysis of the procedure performed with modern robotic technology, a platform that offers enhanced visualization and instrument articulation for precision suturing. Unlike previous studies, Grimsby and colleagues provided a more inclusive definition of pyeloplasty success, which includes: (1) objective improvement of renal function, (2) absence of symptoms, and (3) absence of a repeat operation. Pyeloplasty failure was defined as the failure to fulfill one or more of the three criteria. Included in this analysis was 116 patients who were treated with a variety of robotic pyeloplasty techniques with an 8% (eight patients) failure rate at 17 months of follow-up. The authors found a dramatic reduction of success rate with SRF >30%, having a 97% success rate, compared with SRF <30%, which had a 58% success rate. In the lens of modern surgical techniques and utilizing this ''trifecta'' outcome measurement, there appears to be a profound advantage for renal units with >30% SRF compared with those below <30%.

Conflicting evidence was seen once again in a more recent review of 139 patients that found no difference in surgical outcomes when using an SRF cutoff of 25%.[12] This group found an improvement in renal function for certain individuals as well as progressive decline in others with SRF of <25%.[12] In other words, having a poor preoperative SRF may not influence the trajectory of postoperative renal function. This study suggests that pyeloplasty should not be ruled out in patients with poor SRF (<25%) given the prospect of renal function preservation, and at times improvement of the afflicted kidney.

Another study suggested that the pyeloplasty should still be seen as a viable option, even for patients with dismal renal function (0%–10%) following a period of decompression.[13] In a study of 12 patients with SRF of <10%, all had a doubling of the renal function with decompression alone with a percutaneous nephrostomy tube (PNT) for 4 to 6 weeks. During this time, there was a demonstrable regrowth of renal cortical and medullary parenchyma on serial renal sonographic evaluation.[13] SRF further improved to 35% to 45% following formal repair with a pyeloplasty. This study underlines the importance of renal decompression to accurately evaluate recoverable renal function, which in turn will help dictate surgical management.

In summary, there is conflicting evidence in the literature on the association of preoperative SRF of the affected kidney and pyeloplasty success. These studies are limited by their retrospective nature and power due to low incidence of pyeloplasty failures. Furthermore, a cross comparison in the literature is difficult to perform due to the varying definitions of success among the authors. We find established SRF cutoffs in studies to be set relatively high, with most studies at 30% in comparison to 15% to 20% established by expert opinion to determine the need for nephrectomy *vs* reconstructive procedure.[14]

Patient age as predictor

There are limited data on the relationship of the patient's age at the time of pyeloplasty and pyeloplasty success, with most existing studies evaluating this relationship strictly in the pediatric population. Singla and colleagues investigated the impact of age at the time of repair and pyeloplasty success rates in the adult population.[12] No significant difference was observed in the change in SRF after the surgery when stratified by age ($p = 0.120$). On univariate Cox analysis, older age was predictive of stability or improvement in SRF after the surgery across the entire cohort (hazard ratio [HR] 1.013, $p = 0.016$), whereas preoperative SRF was not (HR 1.007, $p = 0.429$). Thus, the authors concluded that older age is not associated with worse outcomes and older adults should not be excluded from a pyeloplasty when surgery is indicated.[12]

Interestingly, a difference for pyeloplasty success was seen at middle age by another study. In a review of 138 adult patients undergoing Anderson–Hynes dismembered pyeloplasty, patients younger than 35 years were identified as having a recoverable renal function when compared with patients older than 35 years.[10] This phenomenon will need to be validated in the future, but it has limited impact on practice management.

In the adult population, elderly age does not appear to impact the outcome of pyeloplasty, suggesting that this surgery should be offered to older patients if they qualify as a surgical candidate.

Prior endopyelotomy

An endopyelotomy is a minimally invasive alternative to a pyeloplasty with approachable success rates, but those who fail will undoubtedly necessitate a pyeloplasty. Cautionary counseling for those patients undergoing endopyelotomy is of utmost importance as the literature suggests that those who fail may fare worse if a pyeloplasty is pursued in the future. In a study of 759 pyeloplasties, with a mean follow-up time of 15 months, a previous endopyelotomy significantly increased the risk for pyeloplasty failure. Two year freedom from a repeat procedure was seen in 81% *vs* 93% of patients with and without previous endopyelotomy, respectively ($p = 0.001$).[15] Endopyelotomy not only has a lower success rate as initial treatment but also, when failed, can significantly diminish the success of salvage pyeloplasty.[15] This significant reduction in success rate confirms that the pyeloplasty should truly be the gold standard as initial treatment when indicated.

Early urine leak

Early anastomotic urine leak as detected by surgical drain output has also been looked at as a predictor of success. Lim

and Walker's experience of 127 pyeloplasties had a success rate of 98%, but in the three failures, two (66%) had persistently high surgical drain output requiring prolonged drain duration.[16] Seo and coworkers found a pyeloplasty failure rate of 12% (8/65) at a mean follow-up of 3 years.[17] When comparing the success to the failures, none of the following metrics: age, body mass index, abdominal surgical history, initial stricture length, grade of hydronephrosis, presence of an obstructing vessel, operation time, or blood loss were significantly associated with pyeloplasty failures. The only significant variable related to pyeloplasty failure was having a high amount of surgical drain output ($p = 0.024$).

High drain output implies a urine leak from a suboptimal anastomosis due to poor tissue integrity, technical failure, or tissue ischemia when presented in the delayed manner. The presence of a urinary leak can stimulate a caustic reaction at the anastomosis leading to anastomotic stricture with potential for recurrent obstruction.[18]

Presence of stones

The data on the presence of nephrolithiasis and pyeloplasty success stem from retrospective studies evaluating concomitant pyelolithotomy with laparoscopic pyeloplasty. In 2002, Ramakumar and colleagues reviewed 20 laparoscopic pyeloplasties performed with concomitant pyelolithotomy and stone extraction with a success of 90%, a success similar to published reports of pyeloplasty without the presence of stones.[19] Success in this definition was defined by a negative postoperative renal scan and radiographic resolution of hydronephrosis. Stone-free rate was 90% at 3 months after the surgery and 80% at 12 months after the surgery. More recently, Kadihasanoglu and colleagues performed a cohort comparison of 43 adults who underwent laparoscopic pyeloplasty with and without concomitant pyelolithotomy and found a success of 92.9% and 93.3%, respectively, based on a negative renal scan at 3 months following the surgery.[20] Thus, it can be concluded that the presence of stones and concomitant pyelolithotomy has limited impact on the success of pyeloplasty. However, residual stone burden and the risk of postoperative stone formation should be considered as a possible postoperative issue. Efforts should be made at the time of pyeloplasty to thorough evaluation of each calices with flexible nephroscopy to minimize the possibility of residual stones and the need for ancillary procedures.

Histological abnormality

The pathological assessment of the excised obstructing segment of urothelium and renal biopsies may provide a clue to the success of a pyeloplasty repair. Histological characteristics including a reduced number of glomerular apparatus, glomerular hyalinization, cortical cysts, and interstitial inflammation have all been found to be related to cases of severe obstructive uropathy secondary to UPJO.[21] All these histological alterations were found to be present in scarred renal pelvis due to severe obstruction.[21] Thus, it is unclear if the presence of any or a combination of these histological alterations implies an increased risk of failure of the renal unit despite a technically successful pyeloplasty.

Patients with UPJO and differential function of less than 35% had significant histological changes associated with the renal parenchyma itself. One study that performed renal biopsies at the time of pyeloplasty found abnormal histology correlative to poor preoperative and postoperative SRF on radionuclide renal scans.[22] Abnormal biopsies were seen in six patients, of which five had a preoperative differential function of less than 33%. None of these kidneys had an improvement in SRF on repeat scan despite a technically successful procedure.[22] These studies imply that pyeloplasty failure may be a factor of an initial irreversible renal insult at a histological level rather than due to persistent obstruction after repair. These histological analyses suggest that chronic obstruction impacts the histological architecture of the kidney itself, but whether it is a marker for pyeloplasty failure has yet to be determined (see Table 1 for key summary points of risk factors associated with pyeloplasty failures).

Management of Failed Pyeloplasty

Although at a low incidence, pyeloplasty failures unfortunately do occur, often in the first 2 years after the surgery.[6] The decision on secondary intervention should be made based on the definition of failure and with treatment goals in mind. One must recognize the varying definition of failures, which can be simplified to persistence of pain, persistent sequelae of obstruction (infection, stones, or rarely hypertension), continued decline in SRF, or a combination of the above. Failure defined solely by a persistent decline in SRF may not require repeat intervention in the absence of medical sequelae from the progressive failing renal unit. Patients who fail primary pyeloplasty based on persistent symptoms or with recurrent nephrolithiasis or infections can be offered a variety of management options, including salvage pyeloplasty, secondary endopyelotomy, ureterocalicostomy (for the selected few), and nephrectomy.

Salvage pyeloplasty

A repeat pyeloplasty is feasible, and published series have shown promising results with minimal blood loss, minimal complications, and durable success rates.[23] Shapiro and colleagues, in 2009, utilized the success trifecta (radiographic

Table 1. Key Summary Points of Risk Factors Associated with Pyeloplasty Failures

1. There is conflicting evidence in the literature on the association of preoperative SRF and pyeloplasty success.
2. Potential risks associated with failure: SRF <30, a prior endopyelotomy, early urine leak
   Not associated with failure: patient age, presence of stones, concomitant pyelolithotomy
3. Chronic adult UPJO impacts the histological architecture of the kidney potentially contributing to functional failure despite a technically successful pyeloplasty.
4. A robust evaluation of pyeloplasty failures is limited due to the small retrospective nature of existing studies and the inconsistent definition of success/failure.
5. A better understanding of pyeloplasty success can be better evaluated by standardizing the definition of success to include:
   (1) Objective improvement of renal function
   (2) Resolution of subjective symptoms
   (3) The absence of repeat procedures

SRF = split renal function; UPJO = ureteropelvic junction obstruction.

resolution of renal obstruction, absence of symptoms, and stable renal function) to gauge the success of their salvage pyeloplasty experience. The cohort consisted of nine patients who failed a primary open pyeloplasty and underwent a salvage pyeloplasty with a success rate of 89%. This study provided durable (>5 years) evidence in support of salvage laparoscopic pyeloplasty as an excellent option for those who have failed a previous open pyeloplasty.[23] The mean operative time was 204 (80–264) minutes with acceptable estimated blood loss (EBL 105 mL). There were no intraoperative or 30-day postoperative complications.[23]

Contemporary reports on laparoscopic salvage pyeloplasty consisting of larger cohorts provided a higher power of analysis to support the success rate of salvage pyeloplasty. In 2017, Chiancone and coworkers reported the outcomes of transperitoneal laparoscopic salvage pyeloplasty for 38 consecutive patients, most of which (36 patients) had failed primary dismembered pyeloplasty, while 2 patients had failed primary endopyelotomy.[24] The group provided reassuring results that salvage pyeloplasty offered a high success rate of 97.4% defined as the satisfaction of two criteria: absence of symptoms and radiographic resolution of hydronephrosis on postoperative imaging. The perioperative outcomes and success rate of salvage pyeloplasty were also found to be comparable to those of primary pyeloplasty in matched cohort comparisons.[25,26] Ambani and colleagues matched 10 laparoscopic salvage pyeloplasty patients in a 1:3 ratio to 26 patients who underwent a primary laparoscopic pyeloplasty and found no difference in preoperative, intraoperative, or postoperative variables.[25] Notably, the EBL, length of hospital stay, and 30-day Clavian morbidity events were all comparable. At a radiographic and clinical follow-up of 24 months, there was no significant difference in need for reintervention. The only difference noted was the length of operative time. On average, salvage pyeloplasty took 247 minutes compared with primary pyeloplasty, which required 175 minutes of operative time ($p = 0.03$). Similarly, Hammady and colleagues performed a match cohort comparison of 32 salvage cases and found salvage pyeloplasties to have a slightly lower but comparable success rate of 90.6% compared with 94.4% of primary pyeloplasty in the hands of the same surgeons.[26]

Salvage pyeloplasty is equally effective for patients who had failed endoscopic management. Sundaram and colleagues in 2003 published their experience of the laparoscopic salvage pyeloplasty on 36 patients with symptomatic success in 89% and objective response in 94% of their cohort. Symptomatic success, however, was defined by 50% reduction of pain. The combined success rate was 83%.[27]

Minimally invasive (laparoscopic and robotic) salvage pyeloplasty provides a high success rate, ranging from 88% to 97%.[23–27] Our review found that perioperative outcomes of salvage pyeloplasty are comparable to that of primary pyeloplasty. The only exception is the prolonged operative time, which improves with experience.[25,27] It is important to consider reserving salvage pyeloplasty to the hands of high volume minimally invasive surgeons to replicate these results.

Secondary endopyelotomy

In credit to the evolution of surgical instrumentation and minimally invasive techniques, endopyelotomy has now become an acceptable surgical approach for the management of UPJO as primary or salvage treatment in the case of persistent obstruction. There are many described modalities of endoscopic treatment including cold cutting with a hooked-shape knife, Holmium laser ablation, and balloon dilation.[14] The benefit of a salvage endopyelotomy compared with a salvage pyeloplasty is its relative ease, minimally invasive nature, and expedited recovery period. Endopyelotomy may also be considered in patients who have failed multiple pyeloplasties and are no longer accepting further reconstructive surgery. Success rates for secondary endopyelotomy are slightly lower than that of secondary pyeloplasty, ranging from 66% to 87%.[28–32] Secondary endopyelotomy has also been found to be less durable compared with secondary pyeloplasty, as failure tends to occur within a shorter period.[33] One of the first reliable endopyelotomy techniques used in the salvage setting is the hooked knife. Jabbour and colleagues recruited 72 patients who failed a primary open pyeloplasty and performed an antegrade endopyelotomy with a monopolar electrocautery hooked knife with a success rate of 87.5% (63/72). Success was defined clinically and radiographically at a long follow-up of 88.5 months.[30] Other modalities of secondary endopyelotomy include endoscopic balloon dilation, cold knife incision, and laser ablation, all presented as case reports or small series with lower success rates of 70%.[28,34] Balloon dilation as a salvage procedure has had the lowest success rate, which may be due to its inability to produce a full-depth ablation of the scar tissue.[28]

In its infancy, the efficacy of Holmium laser ablation for failed UPJO repair was merely reported in small case series that provided cautionary success rates.[31] Di Grazia and Nicolosi reported the experience of six patients who failed primary pyeloplasty and underwent retrograde Holmium laser endopyelotomy. Only four patients (66%) reached success at 3 months following the surgery. There was no advantage for hospital stay as the patients remained hospitalized on an average of 2 days, although this may be reflective of the surgeon's preferred postoperative pathway.[31] In recent decades, endopyelotomy has been the most popular secondary treatment for pyeloplasty failure for the advantages that we had previously described.[35] It has been suggested that success rates may be improved with proper selection of patients, particularly omitting patients with a crossing vessel and those with high-grade obstruction. Proper patient selection brings the success rate to 95%, which is comparable to that of pyeloplasty.[36–39] The success of salvage endopyelotomy may also be enhanced with a ureteral stent placement before endopyelotomy.[40] Acher and coworkers identified 15 patients who failed primary pyeloplasty, of which 11 patients had ureteral stents placed before endopyelotomy. An incisional endopyelotomy was performed followed by 7F stent placement for 6 weeks postoperatively. All patients had repeat intravenous urograms and renograms at 3 months postprocedurally. Three (20%) patients failed, all of whom were not stented before endopyelotomy.

Comparison of salvage pyeloplasty vs *secondary endopyelotomy*

No randomized prospective head-to-head comparisons of salvage pyeloplasty and secondary endopyelotomy have been completed. The most robust head-to-head comparisons are

Table 2. Series of Salvage Pyeloplasty and Secondary Endopyelotomy Following Failed Pyeloplasty

Study	*Salvage procedure*	n	*Operative time (minutes)*	*EBL (mL)*	*Convalescence days (range)*	*Success*	*Definition of success*
Shapiro et al.[23]	Salvage pyeloplasty (laparoscopic)	9	204 (80–264)	105	2.1	8/9 (89%)	Resolution of symptoms Stable or improved renal function on renal scan Patent ureteropelvic junction on IVP
Grimsby et al.[11]	Salvage pyeloplasty (robotic)	116	N/A	N/A	N/A	108/116 (92%)	Objective improvement on renal scan Resolution of symptoms No need for further intervention
Chiancone et al.[24]	Salvage pyeloplasty (laparoscopic)	38	103 ± 30	122.37 ± 73.2	4.47 ± 0.86	32/38 (84%)	Postoperative renal scan with T1/2 ≤ 10
Ambani et al.[25]	Salvage pyeloplasty (laparoscopic)	10	247	110 (25–175)	2.4	10/10 (100%)	Need for repeat intervention
Hammady et al.[26]	Salvage pyeloplasty (laparoscopic)	32	133 ± 42	N/A	2.7 ± 2.3	29/32 (90.6%)	Symptomatic relief Radiological improvement
Jabbour et al.[30]	Secondary endopyelotomy (Hook electrocautery)	72	N/A	N/A	N/A	63/72 (87.5%)	Resolution of pain and urinary tract infections Prompt secretion of contrast on IVP
Di Grazia and Nicolosi[31]	Secondary endopyelotomy (Holmium laser)	6	N/A	N/A	2.1	4/6 (66.6%)	Radiographic resolution
Park et al.[28]	Secondary endopyelotomy	20	N/A	N/A	4.7 (3–10)	14/20 (70%)	Symptomatic improvement Stable or improved renal function Improved renal scan
Acher et al.[40]	Secondary endopyelotomy (Holmium laser)	15	N/A	N/A	2.4	15/15 (100%)	Symptomatic improvement Improved drainage
Varkarakis et al.[34]	Secondary endopyelotomy	9	N/A	N/A	N/A	8/9 (88.9%)	Symptomatic relief Improved radiographic imaging
Vannahme et al.[33]	Secondary endopyelotomy Salvage pyeloplasty	17 41	N/A	N/A	N/A	44% 87.5%	Symptomatic success Resolution of obstruction No need for further intervention
Swearingen et al.[35]	Secondary endopyelotomy Salvage pyeloplasty Nephrectomy	29 3 9	40.35 (10–135) 199 (123–315)	3 (0–50) 83 (25–175)	0.3 (0–2) 1.3 (1–2)	13/34 (38%) 3/3 (100%)	No need for further intervention

EBL = estimated blood loss; IVP = excretory urography; N/A = not available.

two large retrospective reviews with prospective collection of data.[33,35] Vannahme and colleagues looked at those who failed either pyeloplasty or endopyelotomy and found undeniably better results favoring salvage pyeloplasty over secondary endopyelotomy.[33] Subjective success as defined by resolution of symptoms was 87% *vs* 74% favoring secondary pyeloplasty. Notably, the difference in success was more pronounced when incorporating objective measures of success on renal scan (94% *vs* 74%) and a need for a repeat procedure (96% *vs* 71%). Substantial difference in the two therapies was seen when utilizing the success trifecta, which was overall 87.5% for secondary pyeloplasty and 44% for secondary endopyelotomy.[33]

Swearingen and colleagues also found a strong preference for salvage pyeloplasty over secondary endopyelotomy.[35] In a review of 41 patients who failed initial pyeloplasty, success rate for pyeloplasty used in the secondary and tertiary setting was 100% compared with 38% for endopyelotomy. Limitation for this study is that failure was defined only as the need for repeat procedure.

In head-to-head comparisons, secondary endopyelotomy is technically simpler and is a significantly quicker operation than salvage pyeloplasty.[35] Risk of postoperative complications also favored secondary endopyelotomy. Studies indicate that complications associated with endopyelotomy tend to be infectious in nature, whereas the leading complications with pyeloplasties included postoperative bleeding and early anastomotic urine leak.[35]

In regard to cost-effectiveness, the cost of secondary therapy can be extrapolated from the literature on primary treatment of adult UPJO.[41] In this analysis of the MarketScan® database, both open and minimally invasive pyeloplasties were more costly than endopyelotomy ($\sim$\$22,000 *vs* \$16,000).[36] Despite this cost advantage, we feel that salvage pyeloplasty should still be the gold standard given it superior success rate. Furthermore, failure with secondary endopyelotomy would potentiate costs if failure is encountered and a tertiary procedure is necessitated.

Interestingly, when fully informed and given the choice to decide, most patients prefer endoscopic management for the benefit of minimally invasive approach and low complication rate.[34] All the aforementioned factors must weighed in consideration to help determine the best approach for a patient with failed UPJ repair.

Refer to Table 2 for a summary comparison of salvage pyeloplasty *vs* secondary endopyelotomy.

Table 3. Key Summary Points on the Management of Pyeloplasty Failures

1. A minimally invasive salvage pyeloplasty is the gold standard treatment for recurrent UPJO given its high success rate.
2. Secondary endopyelotomy is an acceptable alternative therapy for treatment of recurrent UPJO, although with a lower success rate than salvage pyeloplasty.
3. Ureterocalicostomy is a highly selective procedure performed in the unique circumstance of multiple reoperated field.
4. Nephrectomy is considered for renal units with nonsalvageable function (GFR <15%).

GFR = glomerular filtration rate.

Ureterocalicostomy

An ureterocalicostomy can be offered under unique circumstances. Initial porcine model demonstrated pure laparoscopic success for long upper ureteral strictures measuring up to 2 cm.[42] This is a feasible approach in patients who have failed multiple (two or more) pyeloplasties, have insufficient renal pelvis tissue for reconstruction, and have a dilated, thinned out lower pole calix available for an uretercaliceal anastamosis.[43] Series of minimally invasive ureterocalicostomies showed 100% success rate at a mean of 30 months of follow-up with no major complications.[43–45]

Nephrectomy

A laparoscopic total nephrectomy may be the definitive procedure of choice for failed primary surgical therapy, particularly if a normal contralateral kidney is present based on radiographic and nuclear studies. Indications include persistent pain, urinary tract infection, stones, or rarely, causal hypertension secondary to urinary obstruction. Generally, SRF of <15% is considered nonsalvageable in adults,[14] although prior mentioned studies may disagree and find renal decompression with either an internalized stent or a PNT to salvage function.[13] Nephrectomy may also be a wise choice in patients who have failed multiple repairs, in which case reoperation may be extremely challenging (see Table 3 for key summary points on the management of pyeloplasty failures).[14]

Summary

Management of failed pyeloplasty should be based on the definition of failure with consideration of anatomical factors, patient preference, and the surgeon experience and comfort level. Salvage pyeloplasty portends the highest success rate and should be the gold standard for secondary therapy if feasible. Secondary endopyelotomy can be an alternative approach for those patients who do not desire salvage pyeloplasty. With careful selection of patients (omittance of high-grade obstruction and presence of crossing vessel), secondary endopyelotomy success approaches salvage pyeloplasty. Finally, an ureterocalicostomy is a highly selective procedure performed in the unique circumstance of multiple reoperated field, whereas nephrectomy will be definitive therapy for renal units with nonsalvageable function (glomerular filtration rate <15%) even after decompression.

A better understanding of pyeloplasty success can be better evaluated by standardizing the definition of success to include objective improvement of renal function, resolution of subjective symptoms, and the absence of repeat procedures. Future initiatives should include multi-institutional efforts in prospective analysis to evaluate this relationship.

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References

1. Jacobs JA, Berger BW, Goldman SM, et al. Ureteropelvic obstruction in adults with previously normal pyelograms: A report of five cases. J Urol 1979;121:242.

2. Gurbuz C, Best SL, Donnally C, et al. Intermediate term outcomes associated with the surveillance of ureteropelvic junction obstruction in adults. J Urol 2011;185:926.
3. Turk IA, Davis JW, Winkelmann B, et al. Laparoscopic dismembered pyeloplasty—The method of choice in the presence of an enlarged renal pelvis and crossing vessels. Eur Urol 2002;42:268.
4. Inagaki T, Rha KH, Ong AM. Laparoscopic pyeloplasty: Current status. BJU Int 2005;95:102.
5. Bachmann A, Ruszat R, Forster T, et al. Retroperitoneoscopic pyeloplasty for ureteropelvic junction obstruction (UPJO): Solving the technical difficulties. Eur Urol 2006;49:264.
6. Madi R, Roberts WW, Wolf JS, Jr. Late failures after laparoscopic pyeloplasty. Urology 2008;71:677.
7. Bansal R, Ansari MS, Srivastava A, et al. Long-term results of pyeloplasty in poorly functioning kidneys in the pediatric age group. J Pediatr Urol 2012;8:25–28.
8. Chiou YY, Chiu NT, Wang ST, et al. Factors associated with the outcomes of children with unilateral ureteropelvic junction obstruction. J Urol 2004;171:397–402.
9. Ortapamuk H, Naldoken S, Tekdogan UY, et al. Differential renal function in the prediction of recovery in adult obstructed kidneys after pyeloplasty. Ann Nucl Med 2003; 17:663–668.
10. Li XD, Wu YP, Wei Y, et al. Predictors of recoverability of renal function after pyeloplasty in adults with ureteropelvic junction obstruction. Urol Int 2018;100:209–215.
11. Grimsby GM, Jacobs MA, Gargollo PC. Success of laparoscopic robot-assisted approaches to ureteropelvic junction obstruction based on preoperative renal function. J Endourol 2015;29:874–877.
12. Singla N, Lay AH, Cadeddu JA. Poor split renal function and age in adult patients with ureteropelvic junction obstruction do not impact functional outcomes of pyeloplasty. Can J Urol 2016;23:8457–8464.
13. Aziz MA, Hossain AZ, Banu T, et al. In hydronephrosis less than 10% kidney function is not an indication for nephrectomy in children. Eur J Pediatr Surg 2002;12:304–307.
14. Nakada S, Best S. Management of Upper Urinary Tract Obstruction. Campbell Walsh Urology, 11th Edition, Chapter 49, pp. 1108–1125. Philadelphia 2016.
15. Lucas SM, Sundaram CP, Wolf JS, Jr, et al. Factors that impact the outcome of minimally invasive pyeloplasty: Results of the Multi-institutional Laparoscopic and Robotic Pyeloplasty Collaborative Group. J Urol 2012;187:522–527.
16. Lim DJ, Walker RD, III. Management of the failed pyeloplasty. J Urol 1996;156(2 Pt 2):738–740.
17. Seo IY, Oh TH, Lee JW. Long-term follow-up results of laparoscopic pyeloplasty. Korean J Urol 2014;55:656–659.
18. Tyritzis SI, Katafigiotis I, Constantinides CA. All you need to know about urethrovesical anastomotic urinary leakage following radical prostatectomy. J Urol 2012;188:369–376.
19. Ramakumar S, Lancini V, Chan D, et al. Laparoscopic pyeloplasty with concomitant pyelolithotomy. J Urol 2002; 167:1378–1380.
20. Kadihasanoglu M, Yucetas U, Karabay E, et al. Comparison of the outcomes of laparoscopic pyeloplasty with and without concomitant pyelolithotomy. Int Braz J Urol 2019; 45:965–973.
21. Elder JS, Stansbrey R, Dahms BB, et al. Renal histological changes secondary to ureteropelvic junction obstruction. J Urol 1995;154(2 Pt 2):719–722.
22. Stock JA, Krous HF, Heffernan J, et al. Correlation of renal biopsy and radionuclide renal scan differential function in patients with unilateral ureteropelvic junction obstruction. J Urol 1995;154(2 Pt 2):716–718.
23. Shapiro EY, Cho JS, Srinivasan A, et al. Long-term follow-up for salvage laparoscopic pyeloplasty after failed open pyeloplasty. Urology 2009;73:115–118.
24. Chiancone F, Fedelini M, Pucci L, et al. Laparoscopic management of recurrent ureteropelvic junction obstruction following pyeloplasty: A single surgical team experience with 38 cases. Int Braz J Urol 2017;43:512–517.
25. Ambani SN, Yang DY, Wolf JS, Jr. Matched comparison of primary versus salvage laparoscopic pyeloplasty. World J Urol 2017;35:951–956.
26. Hammady A, Elbady M, Rashed EN, et al. Laparoscopic repyeloplasty after failed open repair of ureteropelvic junction obstruction: A case-matched multi-institutional study. Scand J Urol 2017:51:402–406.
27. Sundaram C, Grubb RL, III, Rehman J, et al. Laparoscopic pyeloplasty for secondary ureteropelvic junction obstruction. J Urol 2003;169:2037–2040.
28. Park J, Kim WS, Hong B, et al. Long-term outcome of secondary endopyelotomy after failed primary intervention for ureteropelvic junction obstruction. Int J Urol 2008;15: 490–494.
29. El-Nahas AR, Shoma AM, Eraky I, et al. Percutaneous endopyelotomy for secondary ureteropelvic junction obstruction: Prognostic factors affecting late recurrence. Scand J Urol Nephrol 2006;40:385–390.
30. Jabbour ME, Goldfischer ER, Kilma WJ, et al. Endopyelotomy after failed pyeloplasty: The long-term results. J Urol 1998;160:690–692.
31. Di Grazia E, Nicolosi D. Ureteroscopic laser endopyelotomy in secondary UPJ obstruction after pyeloplasty failure. Urol Int 2005;75:333–336.
32. Patel T, Kellner CP, Katsumi H, et al. Efficacy of endopyelotomy in patients with secondary ureteropelvic junction obstruction. J Endourol 2011;25:587–591.
33. Vannahme M, Mathur S, Davenport K, et al. The management of secondary pelvi-ureteric junction obstruction—A comparison of pyeloplasty and endopyelotomy. BJU Int 2014;113:108–112.
34. Varkarakis IM, Bhayani SB, Allaf ME. Management of secondary ureteropelvic junction obstruction after failed primary laparoscopic pyeloplasty. J Urol 2004;172:180–182.
35. Swearingen R, Ambani S, Faerber GJ, et al. Definitive management of failure after pyeloplasty. J Endourol 2016; 30 Suppl 1:S23–S27.
36. Van Cangh PJ, Wilmart JF, Opsomer RJ, et al. Long-term results and late recurrence after endoureteropyelotomy: A critical analysis of prognostic factors. J Urol 1994;151:934.
37. Gupta M, Tuncay OL, Smith AD. Open surgical exploration after failed endopyelotomy: A 12-year perspective. J Urol 1997;157:1613.
38. Danuser H, Ackermann DK, Bohlen D, et al. Endopyelotomy for primary ureteropelvic junction obstruction: Risk factors determine the success rate. J Urol 1998; 159:56.
39. Nakada SY, Wolf JS, Jr, Brink JA. Retrospective analysis of the effect of crossing vessels on successful retrograde endopyelotomy outcomes using spiral computerized tomography angiography. J Urol 1998;159:62.

40. Acher PL, Nair R, Abburaju JS, et al. Ureteroscopic holmium laser endopyelotomy for ureteropelvic junction stenosis after pyeloplasty. J Endourol 2009;23: 899–902.
41. Jacobs B, Seelam R, Lai J, et al. Cost analysis of treatments for ureteropelvic junction obstruction. J Endourol 2017;31: 204–209.
42. Cherullo EE, Gill IS, Ponsky LE, et al. Laparoscopic ureterocalicostomy: A feasibility study. J Urol 2003;169:2360–2364.
43. Gite VA, Siddiqui AK, Bote SM, et al. Ureterocalycostomy—Final resort in the management of secondary pelvi-ureteric junction obstruction: Our experience. Int Braz J Urol 2016;42: 501–506.
44. Arap MA, Andrade H, Torricelli FC, et al. Laparoscopic ureterocalicostomy for complicated upper urinary tract obstruction: Mid-term follow-up. Int Urol Nephrol 2014; 46:865.
45. Casale P, Mucksavage P, Resnick M, et al. Robotic ureterocalicostomy in the pediatric population. J Urol 2008; 180:2643.

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Abbreviations Used
EBL = estimated blood loss
GFR = glomerular filtration rate
HR = hazard ratio
IVP = excretory urography
N/A = not available
PNT = percutaneous nephrostomy tube
SRF = split renal function
UPJO = ureteropelvic junction obstruction

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Editorial Comment on: "Risk Factors and Management Options for the Adult Failed Ureteropelvic Junction Obstruction Repair in the Era of Minimally Invasive and Robotic Approaches: A Comprehensive Literature Review" by Chow et al.

Phillip Mucksavage, MD

FAILURE AFTER A PROCEDURE that boasts a >90% success rate is one of the most frustrating situations faced by a surgeon. As surgeons, we use failures as tools for learning and methods to identify practices for improvement. For many procedures, failures can often be traced to certain techniques or patient conditions that tend to result in poorer outcome. This is not so in pyeloplasty. With success rates reported between 90% and 100% in modern robotic surgery series, failure after pyleoplasty can be as frustrating to the surgeon as it is to the patient. A failure after pyleoplasty often leads us scratching our heads in confusion.

In the preceding review, Chow et al. studied failure after pyleoplasty in a method to identify potential causes.[1] They reviewed data on five different potential factors that could lead to failure after pyeloplasty, including (1) patient renal function at the time of surgery, (2) age, (3) prior intervention (endopyelotomy) and early urine leak, (4) presence of stone, and (5) histologic abnormalities on renal biopsy. Only urine leak after surgery or before (caused by endopyelotomy) and histologic abnormalities seemed to contribute to failure. These are rare situations and largely out of our control. Unless subclinical urinary leaks are the primary source of failures in patients without previous endopyelotomy, these findings bring no solace to the surgeon or patient who otherwise underwent an uneventful pyeloplasty.

Not all failures are really failures. Patients may have poor drainage, however, maintain function and be symptom free. In those situations, no intervention and continued follow-up are all that is necessary. However, when interventions are needed, it appears that most pyeloplasty failures can be salvaged with an endopyelotomy or redo pyeloplasty. A redo pyeloplasty appears to have better outcomes with more durable result compared with endo pyelotomy, but the majority of patients would prefer the less invasive treatment before a redo surgery.

Although this review tries to put a light on the etiology of pyeloplasty failures, it really highlights our failures. Our

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