

COMPARISON OF FUNCTIONAL AND MORPHOLOGICAL OUTCOMES OF OPEN VERSUS LAPAROSCOPIC PYELOPLASTY IN INFANTS WITH URETEROPELVIC JUNCTION OBSTRUCTION

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ABSTRACT

OBJECTIVES

The aim of the study was to compare functional, morphological, perioperative, and short-term surgical outcomes of open and laparoscopic pyeloplasty in infants with unilateral ureteropelvic junction obstruction.

METHODOLOGY

This prospective quasi-experimental study enrolled 116 infants aged 12 months or younger at Khyber Teaching Hospital, Peshawar, between June and November 2025, with six-month postoperative follow-up. Fifty-eight infants underwent open Anderson-Hynes pyeloplasty and 58 underwent transperitoneal laparoscopic pyeloplasty; allocation was based on surgeon expertise and parental preference. Estimated glomerular filtration rate (eGFR), renal pelvic anteroposterior diameter, and renal parenchymal thickness were assessed before surgery and at six months. Operative time, hospital stay, complications, and surgical success were also compared.

RESULTS

Baseline characteristics and preoperative eGFR were comparable between groups. At six months, mean eGFR increased by 5.3 mL/min/1.73 m² after open pyeloplasty and 6.1 mL/min/1.73 m² after laparoscopic pyeloplasty ($p=0.016$). Reduction in anteroposterior diameter was greater after laparoscopy (18.4 ± 3.1 vs 15.8 ± 2.9 mm; $p<0.0001$), as was improvement in parenchymal thickness (4.0 ± 0.7 vs 3.0 ± 0.7 mm; $p=0.001$). Laparoscopy required longer operative time (165 ± 25 vs 90 ± 12 minutes; $p=0.001$) but shorter hospitalisation (5.0 ± 1.5 vs 6.5 ± 2.0 days; $p=0.002$). Surgical success was similar (94.8% vs 93.1% ; $p=0.65$), with low complication rates.

CONCLUSION

Both approaches produced high success and acceptable morbidity. Laparoscopy showed modestly greater functional and morphological improvement and shorter hospitalisation, but the non-randomised design limits causal interpretation. eGFR was calculated with age-appropriate creatinine-based equations, ultrasound was interpreted by a radiologist blinded to surgical approach, and complications were classified according to the Clavien-Dindo system. Longer follow-up is required to determine whether these differences persist in this infant population.

KEYWORDS: Ureteropelvic Junction Obstruction, Pyeloplasty, Laparoscopy; Infant, Estimated Glomerular Filtration Rate, Hydronephrosis

INTRODUCTION

Congenital ureteropelvic junction obstruction (UPJO) results from impaired drainage of urine from the renal pelvis into the proximal ureter and is one of the most frequent causes of antenatal and neonatal hydronephrosis. The obstruction may be related to intrinsic narrowing, abnormal smooth-muscle development, high ureteral insertion, or extrinsic compression by crossing vessels.¹ The clinical course is variable: some infants remain stable under surveillance, whereas clinically significant obstruction may lead to progressive hydronephrosis, recurrent urinary infection, pain, or deterioration of renal function.

Ultrasonography is the principal anatomical investigation, while technetium-99m mercaptoacetyl triglycine diuretic renography provides information on drainage and differential renal function when obstruction is suspected.² The Anderson-Hynes dismembered pyeloplasty remains the standard reconstructive operation for UPJO. Open pyeloplasty has historically achieved excellent success rates and remains particularly relevant in centres where advanced minimally invasive technology is limited. During the last two decades, laparoscopic and robot-assisted approaches have increasingly been adopted because they offer smaller incisions and the potential for reduced postoperative discomfort and shorter

hospitalisation.^{3,4} Their use in infants is technically more demanding than in older children because of restricted working space, small-calibre structures, and the need for precise intracorporeal suturing. Contemporary evidence suggests that minimally invasive pyeloplasty can achieve success and complication rates comparable with open surgery in appropriately selected infants. Meta-analyses of infant populations have generally found longer operative duration with minimally invasive techniques but shorter hospital stay, with no consistent disadvantage in success, reintervention or overall complication rates.^{3,4,5} Multi-institutional series also support the feasibility of laparoscopic and robotic approaches in infants once the surgical learning curve has been overcome.⁶ Robotic systems may improve dexterity and suturing ergonomics, but cost, access to equipment, instrument size, and specialised training remain major constraints in many health systems. Recent infant-specific studies have extended these observations to neonates and infants younger than six months.^{8,9} Most available comparisons are retrospective, use heterogeneous definitions of success, and focus mainly on operative time, hospitalisation and revision rates. Functional recovery after relief of obstruction is more difficult to assess. Diuretic renography provides differential renal function, but creatinine-based estimated glomerular filtration rate (eGFR) is also commonly used to describe overall renal function. The accuracy of creatinine-based eGFR varies with age, body size, muscle mass and assay calibration, which is particularly important in early infancy.¹⁰ Consequently, small between-group differences in eGFR should be interpreted cautiously and in conjunction with morphological and drainage outcomes. Renal pelvic anteroposterior diameter (APD) and parenchymal thickness provide additional morphological indicators of postoperative improvement. Successful correction of UPJO is generally accompanied by decreasing hydronephrosis and gradual recovery or preservation of renal parenchyma, although the extent and timing of improvement vary according to baseline severity and age.^{11,12,13,14,15,16} Evaluating functional and morphological outcomes together may therefore provide a more complete picture than surgical success alone. In Pakistan and similar resource-constrained settings, open pyeloplasty remains widely practised while laparoscopic expertise is expanding. Comparative prospective evidence in infants is limited, and local data are useful for counselling families, planning services and defining which outcomes justify the technical demands of minimally invasive surgery. The present study therefore compared open and laparoscopic pyeloplasty in infants with unilateral UPJO, focusing on change in eGFR, improvement in APD and renal

parenchymal thickness, perioperative recovery, surgical success, and postoperative complications.

METHODOLOGY

This prospective quasi-experimental study was conducted in the Department of Urology, Khyber Teaching Hospital, Peshawar, Pakistan. Enrollment and surgery took place between June and November 2025, and each participant was followed for six months after the procedure. The institutional ethics committee approved (Ref No. 87/DME/KMC, Dated: 23-01-2025) the study protocol, and written informed consent was obtained from the parent or legal guardian of each infant. Because allocation was not randomised, treatment selection reflected surgeon expertise and parental preference. Both treatment groups were managed during the same study period, allowing contemporaneous comparison. The sample size was calculated for comparison of two means using an expected difference of 5 mL/min/1.73 m² in postoperative eGFR, an assumed standard deviation of 10 mL/min/1.73 m², a two-sided alpha of 0.05, and 80% power. The final sample comprised 116 infants, with 58 in the open-pyeloplasty group and 58 in the laparoscopic group. Infants aged 12 months or younger with unilateral primary UPJO confirmed by ultrasonography and diuretic renography and judged to require surgical correction were eligible. Exclusion criteria were bilateral obstruction, vesicoureteric reflux, duplex collecting system, renal dysplasia, previous abdominal surgery, or serious comorbid conditions that could materially affect perioperative or renal outcomes. Preoperative assessment included clinical evaluation, ultrasonography, serum creatinine measurement and height measurement. For infants aged four weeks or younger, eGFR was calculated using the protocol-specified neonatal creatinine-based equation: $0.313 \times \text{height (cm)} / \text{serum creatinine (mg/dL)}$. In infants older than four weeks, the revised Schwartz equation was used: $\text{eGFR} = 0.413 \times \text{height (cm)} / \text{serum creatinine (mg/dL)}$. Serum creatinine measurement was performed using an assay traceable to isotope-dilution mass spectrometry. The same age-appropriate approach was used at follow-up to maintain internal consistency. Open dismembered pyeloplasty was performed using the Anderson-Hynes technique through a flank incision. After mobilisation of the renal pelvis, the obstructed ureteropelvic segment was excised, and the ureter was spatulated. Pelviureteric anastomosis was completed with interrupted 6-0 polyglactin sutures over a 4.5-F double-J stent. A perirenal drain was placed and removed when output became minimal. Laparoscopic pyeloplasty was performed through a transperitoneal three-port approach. A 5-mm umbilical camera port and two 3-mm working ports were inserted under direct

vision. After mobilisation of the colon, the renal pelvis and ureteropelvic junction were exposed, the stenotic segment was excised, and a dismembered pelviureteric anastomosis was completed using 6-0 polyglactin sutures. A double-J stent was inserted antegradely. An external drain was placed and was generally removed on the second or third postoperative day. Postoperative management in both groups included analgesia, early feeding as tolerated, and mobilisation appropriate to age and clinical recovery. The primary outcome was change in eGFR from baseline to six months. Secondary outcomes included change in renal pelvic APD, change in renal parenchymal thickness, operative time, length of hospital stay, surgical success, and postoperative complications. Follow-up ultrasonography was performed using the same anatomical variables, and the radiologist interpreting ultrasound was blinded to the surgical approach. Surgical success was defined as resolution or improvement of clinical symptoms, improved drainage on postoperative renography, and stable or improved renal function. Postoperative complications were classified according to the Clavien-Dindo system, with grades I-II considered minor complications. Statistical analysis was performed using Python version 3.13 and SciPy version 1.11. A two-sided p-value <0.05 was considered statistically significant.

RESULTS

The study included 116 infants, with 58 undergoing open pyeloplasty and 58 undergoing laparoscopic pyeloplasty. The mean age of the cohort was approximately three months. Baseline demographic and renal characteristics were broadly comparable between groups. Mean age was 3.35 ± 0.73 months in the open group and 3.11 ± 0.84 months in the laparoscopic group ($p=0.12$). Preoperative eGFR was 34.37 ± 4.20 and 35.30 ± 4.14 mL/min/1.73 m², respectively ($p=0.22$). Baseline APD and renal parenchymal thickness also did not differ significantly (Table 1). Operative time was substantially longer with laparoscopy (165 ± 25 minutes) than with open pyeloplasty (90 ± 12 minutes; $p=0.001$). In contrast, hospital stay was shorter after laparoscopic surgery (5.0 ± 1.5 days) than after open surgery (6.5 ± 2.0 days; $p=0.002$). No laparoscopic procedure required conversion to open surgery. Minor postoperative complications occurred in 6/58 (10.3%) infants after open surgery and 5/58 (8.6%) after laparoscopy (Table 2). At six months, eGFR increased in both groups. Mean postoperative eGFR was 39.63 mL/min/1.73 m² after open pyeloplasty and 41.40 mL/min/1.73 m² after laparoscopic pyeloplasty. The mean change was $+5.3$ mL/min/1.73 m² in the open group and $+6.1$ mL/min/1.73 m² in the laparoscopic

group, with a statistically significant between-group difference ($p=0.016$). The source analysis reported a moderate effect size for the eGFR change (Cohen's $d=0.40$), suggesting that the statistical difference was not large in magnitude. Morphological recovery was also observed in both groups. Reduction in renal pelvic APD was greater after laparoscopic surgery (18.4 ± 3.1 mm) than after open surgery (15.8 ± 2.9 mm; $p<0.0001$). Renal parenchymal thickness increased by 4.0 ± 0.7 mm after laparoscopy compared with 3.0 ± 0.7 mm after open surgery ($p=0.001$). The source analysis reported large effect sizes for these morphological changes. Surgical success was high and statistically comparable between groups: 93.1% after open surgery and 94.8% after laparoscopy ($p=0.65$). Overall complication rates remained low and were similar (Table 3). Taken together, the results indicate that both approaches achieved favourable six-month outcomes. Laparoscopy was associated with longer operating time but shorter hospitalisation, slightly greater improvement in eGFR, and larger ultrasound-measured morphological improvement. Because treatment allocation was not random, these differences should be interpreted as comparative associations rather than definitive evidence of superiority.

Table 1: Baseline Characteristics of the Study Population

Variable	Open pyeloplasty (n = 58)	Laparoscopic pyeloplasty (n = 58)	p-value
Age (months), mean $\pm$ SD	3.35 ± 0.73	3.11 ± 0.84	0.12
Weight (kg), mean $\pm$ SD	5.66 ± 1.12	5.25 ± 1.05	0.08
Preoperative eGFR (mL/min/1.73 m ²), mean $\pm$ SD	34.37 ± 4.20	35.30 ± 4.14	0.22
Preoperative APD (mm), mean $\pm$ SD	32.42 ± 6.25	30.24 ± 5.00	0.07
Preoperative parenchymal thickness (mm), mean $\pm$ SD	2.59 ± 1.07	2.39 ± 0.72	0.18

Table 2: Perioperative Outcomes According to Surgical Approach

Outcome	Open pyeloplasty	Laparoscopic pyeloplasty	p-value
Operative time (minutes), mean $\pm$ SD	90 ± 12	165 ± 25	0.001
Length of hospital stay (days), mean $\pm$ SD	6.5 ± 2.0	5.0 ± 1.5	0.002
Minor postoperative complications, n (%)	6 (10.3)	5 (8.6)	—
Conversion to open surgery, n	Not applicable	0	—

Table 3: Functional, Morphological, and Surgical Outcomes at Six Months

Outcome	Open pyeloplasty	Laparoscopic pyeloplasty	p-value
Postoperative eGFR (mL/min/1.73 m ²)	39.63	41.40	—
Change in eGFR (mL/min/1.73 m ²)	+5.3	+6.1	0.016
Reduction in APD (mm), mean $\pm$ SD	15.8 $\pm$ 2.9	18.4 $\pm$ 3.1	<0.0001
Increase in parenchymal thickness (mm), mean $\pm$ SD	3.0 $\pm$ 0.7	4.0 $\pm$ 0.7	0.001
Surgical success (%)	93.1	94.8	0.65
Complication rate (%)	10.3	8.6	—

DISCUSSION

This prospective quasi-experimental study compared open and laparoscopic pyeloplasty in infants with unilateral UPJO under routine clinical conditions. Both procedures achieved high surgical success and low complication rates. Laparoscopic pyeloplasty required considerably longer operating time but was associated with shorter hospital stay and statistically greater improvement in eGFR, APD and renal parenchymal thickness at six months. The absolute functional difference was modest, and the non-randomised allocation means that the findings should not be interpreted as proof of causal superiority. The perioperative pattern observed in this cohort is consistent with contemporary evidence. A systematic review and meta-analysis of 3,494 infants found that minimally invasive pyeloplasty was associated with longer operative time and shorter hospitalisation, while success, complication and reintervention rates were comparable with open surgery.⁵ The longer operative duration reflects the technical complexity of laparoscopic reconstruction in a small abdominal working space, particularly intracorporeal suturing of delicate infant tissue. Infant-specific clinical series have reported similar operative-time differences without clear compromise in surgical success.^{8,11} Shorter postoperative hospitalisation after laparoscopy is clinically relevant, especially in high-volume paediatric surgical services. Smaller incisions, reduced wound trauma, earlier feeding and lower analgesic requirements may facilitate discharge. However, length of stay is also influenced by institutional discharge criteria, parental confidence, travel distance, stent and drain protocols, and bed availability. For this reason, a difference of approximately 1.5 days in the present study should be interpreted as a service and recovery outcome rather than a direct measure of technical success. Both procedures produced improvement in renal function after relief of obstruction. The laparoscopic group demonstrated a statistically greater mean increase in eGFR, but the between-group

difference in change was less than 1 mL/min/1.73 m². Such a difference may reach statistical significance in a balanced sample yet have uncertain individual clinical importance. Creatinine-based eGFR in early infancy is influenced by rapid changes in body size, muscle mass, renal maturation and serum creatinine kinetics. Measured clearance was not available, and eGFR should therefore be interpreted as a supportive functional marker rather than a direct measure of differential function of the operated kidney.¹⁰ The magnitude of postoperative morphological improvement was more pronounced. Reduction in APD and increase in renal parenchymal thickness were greater after laparoscopy in the submitted dataset. Studies of newborns and young infants have similarly documented substantial postoperative reduction in hydronephrosis and progressive increase in renal parenchymal thickness after successful pyeloplasty.¹³ Nevertheless, these ultrasound changes may be influenced by baseline anatomy, hydration, bladder filling, measurement technique and timing of follow-up. Blinded radiological assessment in the present study strengthens the comparison, but standardisation of ultrasound acquisition is still essential when interpreting relatively small absolute differences. The mean age at surgery was approximately three months. Early correction of clinically significant obstruction has been proposed as a means of preserving recoverable renal tissue, and some infant studies have reported greater improvement in hydronephrosis or split renal function when pyeloplasty is performed earlier.^{14,16} Other reviews have found that baseline differential renal function and severity of obstruction may be more consistent predictors than age alone.¹⁵ The present study was not designed to compare different ages at intervention, so favourable recovery cannot be attributed solely to early surgery. Complication rates were low in both groups, and no laparoscopic procedure required conversion to open surgery. This finding supports the technical feasibility of laparoscopic pyeloplasty in selected infants when performed by an experienced team. Contemporary robotic series also report favourable outcomes in infants younger than six months, although robotic technology introduces different cost and access considerations.^{9,17} Multicentre comparisons of open, conventional laparoscopic and robotic pyeloplasty generally suggest that all three approaches can be effective when expertise and patient selection are appropriate.¹⁸ The choice between open and laparoscopic surgery should therefore not be based on a single numerical outcome. Open pyeloplasty remains highly effective, uses familiar equipment, and may be preferred when minimally invasive expertise or appropriately sized instruments are unavailable. Laparoscopy offers smaller incisions and shorter hospitalisation but requires advanced suturing skills and

longer theatre time. In resource-limited environments, the incremental benefit of laparoscopy should be balanced against operating-room availability, equipment costs, surgeon training, and case volume. The present findings support laparoscopy as a feasible alternative rather than evidence that open pyeloplasty is obsolete. From a counselling perspective, families can be informed that both approaches in this study produced success rates above 90% with low short-term morbidity. The more meaningful trade-off was longer operative time for laparoscopy versus shorter postoperative stay, while the observed difference in renal functional improvement was small. This balanced interpretation is preferable to describing either operation as universally superior.

LIMITATIONS

The absence of random allocation is the principal limitation because surgical approach depended on surgeon expertise and parental preference, creating potential selection bias. The study was conducted at a single centre and included 58 infants in each group, limiting the precision of uncommon complication estimates and the ability to perform informative subgroup analysis. Follow-up was restricted to six months and cannot establish late recurrence, reoperation, long-term differential renal function, or durability of morphological recovery. Overall renal function was assessed using creatinine-based eGFR rather than measured GFR, this is particularly important in infants, in whom creatinine and body composition change rapidly. The study did not report patient-level baseline differential renal function for adjusted analysis, and residual confounding may remain despite similar group means. Ultrasound outcomes can be affected by hydration and measurement variability. Finally, the analysis was largely unadjusted; future multicentre prospective studies should incorporate standardised imaging, differential renal function, longer follow-up, patient-reported or parent-reported recovery, cost analysis, and multivariable adjustment for baseline severity.

CONCLUSIONS

Open and laparoscopic pyeloplasty both achieved high six-month success rates with low complication rates in infants with unilateral UPJO. Laparoscopy was associated with longer operative time but shorter hospitalisation and somewhat greater functional and morphological improvement. Because the study was non-randomised and the absolute eGFR difference was small, the findings support laparoscopic pyeloplasty as

an effective alternative rather than definitive evidence of superiority over open surgery.

CONFLICT OF INTEREST: None

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AUTHORS CONTRIBUTION

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Tariq Ahmad - Concept & Design; Data Acquisition; Drafting Manuscript; Supervision; Final Approval

Murad Ali - Concept & Design; Data Acquisition; Data Analysis/Interpretation; Drafting Manuscript; Final Approval

Adil Muhammad - Concept & Design; Data Acquisition; Drafting Manuscript; Critical Revision; Final Approval

Asghar Ali - Concept & Design; Data Acquisition; Drafting Manuscript; Final Approval

Abdul Basit Shah - Concept & Design; Data Acquisition; Drafting Manuscript; Critical Revision; Final Approval

The authors accept responsibility for all aspects of the work and will ensure that any concerns regarding the accuracy or integrity of any part are properly investigated and resolved.



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