

Single-Port Versus Multiport Robot-Assisted Laparoscopic Pyeloplasty in Children With Ureteropelvic Junction Obstruction: A Systematic Review and Meta-Analysis

Muhammad Nadhif Jovaldy^{1*}, Muhammad Aditya Pasya², Ahmad Furqon Abdusyakur³, Ananda Firdaus⁴, Afifah Humairah Putri Hasya⁵

¹General Practitioner, Pertamina Jaya Hospital, Jakarta, Indonesia.

²General Practitioner, Ciawi Regional General Hospital, Bogor, Indonesia.

³General Practitioner, Sentra Medika Cicalak Hospital, Depok, Indonesia.

⁴General Practitioner, Gatot Subroto Army Central Hospital, Jakarta, Indonesia.

⁵General Practitioner, Menteng Mitra Afia Hospital, Jakarta, Indonesia.

*Corresponding author: Muhammad Nadhif Jovaldy, Email: muhammadnadhifjovaldy@gmail.com

Abstract

Objective: To compare perioperative and clinical outcomes between single-port robot-assisted laparoscopic pyeloplasty and multiport robot-assisted laparoscopic pyeloplasty in children with ureteropelvic junction obstruction.

Data source: A systematic search of PubMed and Scopus was conducted from database inception to the final search date. Randomized and non-randomized comparative studies involving children younger than 18 years with ureteropelvic junction obstruction were eligible. Outcomes included operative time, length of hospital stay, estimated blood loss, surgical success, postoperative pain, and cosmetic satisfaction.

Data synthesis: Seven comparative studies were included. Meta-analysis was feasible for operative time and length of hospital stay. No significant difference was found in operative time (standardized mean difference, 1.09; 95% confidence interval, -1.99 to 4.17; $I^2 = 97\%$) or length of hospital stay (standardized mean difference, 0.25; 95% confidence interval, -0.24 to 0.75; $I^2 = 8\%$). Estimated blood loss could not be quantitatively pooled because of inconsistent reporting, although both approaches generally demonstrated low blood loss. Surgical success rates were high for both techniques, ranging from 94.1% to 100% for multiport procedures and reaching 100% among reported single-port cases. One study reported higher cosmetic satisfaction with the single-port approach (9.40 ± 0.52 versus 8.39 ± 0.92).

Conclusion: Single-port and multiport robot-assisted laparoscopic pyeloplasty demonstrated comparable perioperative outcomes and high surgical success in children with ureteropelvic junction obstruction. The single-port approach may provide better cosmetic satisfaction, although the available evidence remains limited. Further prospective comparative studies are warranted.

Keywords: Ureteropelvic Junction Obstruction; Pyeloplasty; Robotic Surgery; Single-Port Surgery; Multiport Surgery; Paediatric Urology.

Introduction

Ureteropelvic junction obstruction (UPJO) is the most common cause of paediatric hydronephrosis requiring surgical intervention. The condition results from impaired urine drainage at the ureteropelvic junction, leading to progressive renal pelvic dilatation and potential deterioration of renal function if left untreated¹. Surgical correction is indicated in symptomatic patients or those with worsening hydronephrosis, declining differential renal function, recurrent urinary tract infections, or persistent flank pain.^{1,2}

Open Anderson–Hynes dismembered pyeloplasty has long been regarded as the gold standard treatment because of its excellent long-term success rates exceeding 90%³. However, the development of minimally invasive surgery has transformed the management of paediatric UPJO by reducing postoperative pain, shortening hospital stay, improving cosmetic outcomes, and facilitating earlier recovery while maintaining comparable functional success⁴.

Robot-assisted laparoscopic pyeloplasty (RALP) has become one of the preferred minimally invasive techniques for paediatric UPJO.⁵ These technical advantages facilitate precise intracorporeal suturing and reconstruction, particularly in paediatric patients where the operative field is limited. Consequently, multiport robot-assisted laparoscopic pyeloplasty (MP-RALP) has demonstrated

surgical outcomes comparable with conventional open pyeloplasty while offering the benefits of minimally invasive surgery^{5,6}.

Several comparative studies have evaluated SP-RALP and MP-RALP in children with UPJO. However, these studies are limited by relatively small sample sizes, heterogeneous study designs, and inconsistent reporting of perioperative outcomes. Furthermore, most available evidence consists of retrospective comparative studies, with only a limited number of prospective investigations.

Therefore, this systematic review and meta-analysis aimed to compare the perioperative and clinical outcomes of SP-RALP and MP-RALP in paediatric patients with UPJO. The primary outcomes included operative time, surgical success, length of hospital stay, and estimated blood loss, while secondary outcomes included postoperative pain and cosmetic satisfaction.

Methods

Study Design

This systematic review and meta-analysis was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 statement. The review was designed to compare perioperative and clinical outcomes between single-port robot-assisted laparoscopic pyeloplasty (SP-RALP) and multiport robot-assisted laparoscopic pyeloplasty (MP-RALP) in paediatric patients with ureteropelvic junction obstruction.

Eligibility Criteria

Studies were selected according to the Population, Intervention, Comparison, Outcomes (PICO) framework. Population: Children younger than 18 years diagnosed with ureteropelvic junction obstruction. Intervention: Single-port robot-assisted laparoscopic pyeloplasty. Comparison: Multiport robot-assisted laparoscopic pyeloplasty. Outcomes: Operative time, surgical success rate, length of hospital stay, estimated blood loss, postoperative pain assessed using the Visual Analog Scale (VAS), and cosmetic satisfaction.

Randomized controlled trials and non-randomized comparative studies, including prospective and retrospective cohort studies, were eligible for inclusion. Case reports, case series without a comparison group, conference abstracts, review articles, editorials, letters, animal studies, and studies involving adult populations were excluded.

Literature Search Strategy

A comprehensive literature search was conducted using PubMed and Scopus from database inception to the final search date. The search combined controlled vocabulary and free-text terms related to ureteropelvic junction obstruction, pyeloplasty, robotic surgery, single-port, multiport, and pediatric populations.

The search strategy included combinations of the following keywords:

("ureteropelvic junction obstruction" OR "UPJO") AND ("robot-assisted pyeloplasty" OR "robotic pyeloplasty") AND ("single-port" OR "single site" OR "single incision") AND ("multiport" OR "multiport") AND ("children" OR paediatric OR paediatric).

Reference lists of all included studies and relevant review articles were manually screened to identify additional eligible studies.

Study Selection

All retrieved records were imported into reference management software, and duplicate records were removed. Two independent reviewers screened titles and abstracts according to the predefined eligibility criteria. Full-text articles were subsequently assessed for inclusion. Disagreements between reviewers were resolved through discussion, and consultation with a third reviewer was performed when consensus could not be achieved.

Data Extraction

Two reviewers independently extracted study characteristics using a standardized data extraction form. The extracted variables included author, publication year, country, study design, sample size, patient demographics, operative technique, follow-up duration, and reported outcomes. For continuous outcomes, means and standard deviations were extracted whenever available. For dichotomous outcomes, the numbers of events and total participants in each group were collected.

Risk of Bias Assessment

The methodological quality of randomized controlled trials was assessed using the Cochrane Risk of Bias 2 (RoB 2) tool, whereas non-randomized studies were evaluated using the Risk of Bias in Non-randomized Studies of Interventions (ROBINS-I) tool. Risk-of-bias assessment was independently performed by two reviewers, with disagreements resolved by consensus.

Statistical Analysis

Meta-analysis was performed using Metaxl. Continuous outcomes were summarized using standardized mean differences (Cohen's d) with corresponding 95% confidence intervals (CI). Dichotomous outcomes were summarized descriptively because of limited comparable data across studies.

Statistical heterogeneity was assessed using Cochran's Q test and quantified using the I^2 statistic. Heterogeneity was interpreted as low ($I^2 < 25\%$), moderate (25–50%), substantial (50–75%), or considerable ($> 75\%$). Given the anticipated clinical and methodological heterogeneity arising from differences in study design and patient characteristics, a random-effects model was applied for all pooled analyses. Statistical significance was defined as a two-sided p -value < 0.05 .

Results

Study Selection and Characteristics

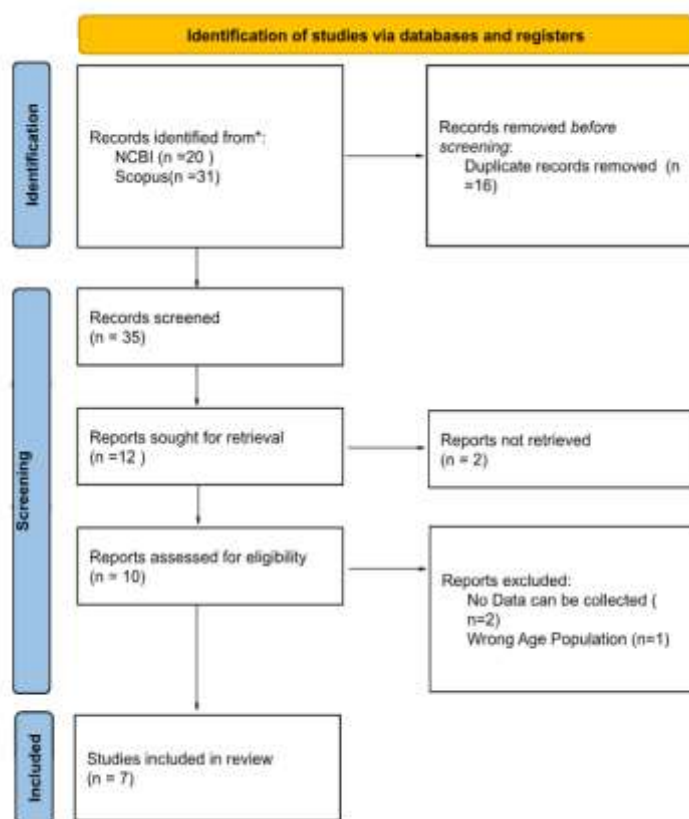


Figure 1. Prisma Diagram

The literature search identified comparative studies evaluating single-port robot-assisted laparoscopic pyeloplasty (SP-RALP) and multiport robot-assisted laparoscopic pyeloplasty (MP-RALP) in paediatric patients with ureteropelvic junction obstruction (UPJO). After removal of duplicates and screening based on predefined eligibility criteria, six comparative studies were included in the systematic review. The included studies consisted of both randomized and non-randomized comparative designs.

Table 1. Characteristics of Included Studies.

No.	Study (Title)	Author, Year	Study Population / Sample Size	Intervention / Comparison
1	Outcomes of Robot-Assisted Laparoscopic Pyeloplasty in Children: A Single Centre Experience	Singh et al., 2012	34 paediatric patients	Multiport robot-assisted laparoscopic pyeloplasty (MP-RALP)
2	Comparison of the Treatment Effect of Laparoscopic and Robot-Assisted Single-Port Laparoscopic Pyeloplasty on Ureteropelvic Junction Obstruction in Infants	He et al., 2025	11 patients	Robot-assisted single-port laparoscopic pyeloplasty (SP-RALP)
3	Comparison of Intraoperative and Short-Term Postoperative Outcomes Between Robot-Assisted Laparoscopic Multi-Port Pyeloplasty Using the da Vinci Si System and Single-Port Pyeloplasty Using the da Vinci SP System in Children	Kang et al., 2020	46 patients (31 MP-RALP; 15 SP-RALP)	MP-RALP using da Vinci Si system vs SP-RALP using da Vinci SP system
4	Robot-Assisted Pyeloplasty and Laparoscopic Pyeloplasty in Children: A Comparison of Single-Port-Plus-One and Multiport Surgery	Chen et al., 2022	38 patients (28 single-port-plus-one RALP; 10 single-port RALP)	Single-port-plus-one robot-assisted pyeloplasty (RMPY) vs single-port robot-assisted pyeloplasty (RSPY)
5	Comparison of the Learning Curve and Outcomes of Robotic Assisted Paediatric Pyeloplasty	Sorensen et al., 2011	33 patients	Multiport robot-assisted laparoscopic pyeloplasty (MP-RALP)
6	Robot-Assisted Laparoscopic Pyeloplasty: Multi-Institutional Experience in Infants	Avery et al., 2015	60 infants	Multiport robot-assisted laparoscopic pyeloplasty (MP-RALP)
7	Comparison of Robotic Pyeloplasty and Standard Laparoscopic Pyeloplasty in Infants: A Bi-Institutional Study	Neheman et al., 2017	21 infants	Multiport robot-assisted pyeloplasty (MP-RALP)

Eight studies (table 1) evaluated perioperative and clinical outcomes between SP-RALP and MP-RALP. Reported outcomes included operative time, surgical success rate, length of hospital stay (LOS), estimated blood loss (EBL), postoperative pain, and cosmetic satisfaction. Due to differences in study design, outcome definitions, and reporting methods, quantitative synthesis was performed only for outcomes with sufficient comparable data.

Meta-analysis of Operative Time

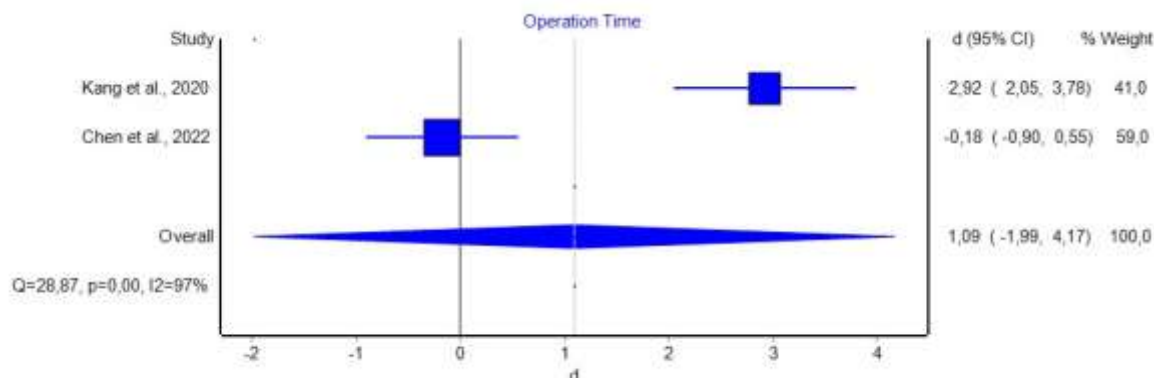


Figure 1. Forest Plot Operation Time

Two studies were included in the meta-analysis of operative time. The pooled analysis demonstrated no statistically significant difference in operative time between the two groups (Cohen's $d = 1.09$, 95% confidence interval [CI]: -1.99 to 4.17) (Figure 1). However, considerable heterogeneity was observed across the included studies ($I^2 = 97\%$; $Q = 28.87$; $p < 0.001$).

Meta-analysis of Length of Hospital Stay

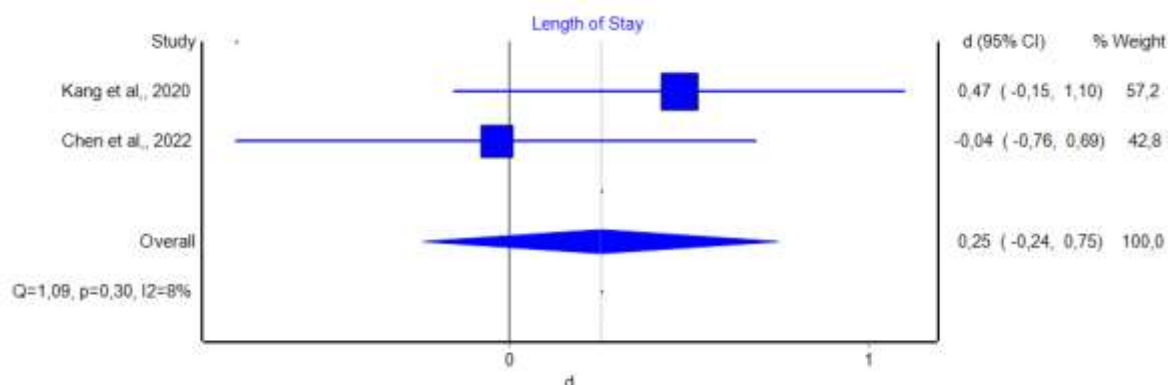


Figure 2. Forest Plot Length of stay

Two studies reported postoperative length of hospital stay. The pooled analysis showed no statistically significant difference between SP-RALP and MP-RALP (Cohen's $d = 0.25$; 95% CI: -0.24 to 0.75). The degree of heterogeneity was low ($I^2 = 8\%$; $p = 0.30$), indicating highly consistent findings across the included studies. These results suggest that the single-port approach does not provide a significant reduction in postoperative hospital stay compared with the conventional multiport approach.

Meta-analysis of Estimated Blood Loss

Table 2. Result of Blood Loss

Study	Multiport (n)	Blood Loss	Single-port (n)	Blood Loss
Singh et al., 2012	34	30	–	–

He et al., 2025	–	–	11	5.27 ± 2.57
Kang et al., 2020	31	50–200	15	<50
Chen et al., 2022	28	6.10 ± 2.28	10	6.28 ± 3.18
Sorensen et al., 2011	33	14 ± 12	–	–

Estimated blood loss was reported in five studies. Two studies (Kang et al., 2020 and Chen et al., 2022) directly compared multiport and single-port approaches, while Singh et al. (2012) reported data only for the multiport group and He et al. (2025) only for the single-port group. Kang et al. reported lower estimated blood loss in the single-port group (<50 mL) compared with the multiport group (50–200 mL). In contrast, Chen et al. found comparable blood loss between the two groups (6.10 ± 2.28 vs. 6.28 ± 3.18 mL). Singh et al. reported a blood loss of 30 mL in the multiport group, whereas Sorensen et al. reported 14 ± 12 mL. He et al. reported a mean blood loss of 5.27 ± 2.57 mL in the single-port group. Overall, blood loss appeared to be low in both surgical approaches; however, differences in reporting methods and outcome measures across studies precluded direct quantitative comparison.

Surgical Success Rate

Table 3. Result of Surgical Success

Studi	Multiport	Single-port
Singh et al., 2012 ⁷	32/34 (94,1%)	-
He et al., 2025 ⁸	-	11/11 (100%)
Kang et al., 2020 ⁹	31/31 (100%)	15/15 (100%)
Avery et al.2015 ¹⁰	59/60 (98,3%)	-
Neheman et al., 2017 ¹¹	20/21 (95,2%)	-

Surgical success was reported in five studies. Both MP-RALP and SP-RALP demonstrated high success rates. In the MP-RALP group, success rates ranged from 94.1% (32/34) to 100% (31/31), whereas the available SP-RALP studies reported a 100% success rate (26/26 across two studies). However, direct comparison between the two approaches remains limited because only one study reported outcomes for both techniques, while the remaining studies evaluated a single surgical approach and included relatively small sample sizes.

Cosmetic Satisfaction

Table 4. Result of Cosmetic Satisfaction

Study	Multiport (n=28)	Single-port (n=10)
Chen et al.	8,39 ± 0,92	9,40 ± 0,52

Cosmetic satisfaction was reported in only one study. The mean cosmetic satisfaction score was higher in the SP-RALP group compared with the MP-RALP group (9.40 ± 0.52 vs. 8.39 ± 0.92). However, because this outcome was reported by a single study, the finding should be interpreted cautiously.

Discussion

This systematic review and meta-analysis evaluated the comparative outcomes of single-port versus multiport robot-assisted laparoscopic pyeloplasty in children with ureteropelvic junction obstruction. The findings demonstrate that SP-RALP provides comparable perioperative outcomes to MP-RALP, with no significant differences in operative time, length of hospital stay, or estimated blood loss. Both approaches achieved excellent surgical success rates, supporting the feasibility of SP-RALP as an alternative minimally invasive technique in paediatric UPJO.

Operative time is an important consideration when introducing new minimally invasive surgical techniques. Although the pooled effect estimate suggested a relatively large effect size, the confidence interval was wide and crossed the null value, indicating no statistically significant difference between SP-RALP and MP-RALP^{9,12,13}. The substantial heterogeneity observed in this analysis likely reflects variations in surgeon experience, robotic platform availability, institutional protocols, and the learning curve associated with single-port robotic surgery. Single-port procedures may initially require additional operative time due to challenges related to instrument positioning and reduced triangulation; however, increasing surgical experience may reduce these differences. The analysis of length of hospital stay demonstrated similar postoperative recovery between the two techniques. This finding suggests that the reduction in incision number associated with SP-RALP may not translate into measurable differences in hospitalization duration^{9,12,13}. Both approaches benefit from the advantages of robotic minimally invasive surgery, including reduced tissue trauma, enhanced precision, and early postoperative recovery.

Estimated blood loss was also comparable between groups, with no evidence of heterogeneity. This finding indicates that the single-port approach maintains adequate surgical control and does not increase intraoperative bleeding risk despite technical challenges associated with a single access platform^{12,13}. The surgical success rates observed in this review were consistently high for both techniques, exceeding 90% in all included studies. These results are consistent with previous evidence demonstrating that robotic pyeloplasty provides excellent functional outcomes in paediatric UPJO⁷⁻¹².

One potential advantage of SP-RALP is improved cosmetic satisfaction.¹³ The single incision approach may be particularly relevant in paediatric patients, where minimizing visible scars can have long-term psychological and aesthetic benefits. However, cosmetic outcomes were reported in only one study, limiting the strength of this conclusion. Future studies should incorporate validated patient-reported outcome measures to better evaluate the cosmetic and quality-of-life benefits of single-port surgery. This study has several limitations. The number of available comparative studies remains small, limiting statistical power. Finally, several clinically relevant outcomes, including postoperative pain and cosmetic satisfaction, lacked sufficient data for meta-analysis. Despite these limitations, this review provides current evidence suggesting that SP-RALP is a safe and effective alternative to MP-RALP for paediatric UPJO. High-quality prospective comparative studies with standardized outcome reporting are required to further define the potential advantages of the single-port approach.

Conclusion

Single-port robot-assisted laparoscopic pyeloplasty demonstrates comparable perioperative outcomes and surgical success rates to multiport robot-assisted laparoscopic pyeloplasty in children with ureteropelvic junction obstruction. No significant differences were observed in operative time, length of hospital stay, or estimated blood loss. SP-RALP may provide improved cosmetic outcomes; however, current evidence remains limited due to the small number of comparative studies. Further large-scale prospective studies are needed to establish the long-term clinical benefits and potential advantages of single-port robotic surgery in paediatric pyeloplasty.

Conflict of interest: The authors declare that they have no conflict of interest.

Funding: This research received no specific grant from any funding agency

References

1. Kumar G, Weinstein I, Stern JM, Badreldin AM. Ureteropelvic Junction Obstruction. The Ureter: A Comprehensive Review. 2026 Feb 26;93–111. doi:10.1007/978-3-031-36212-5_4 PubMed PMID: 32809575.
2. Sadghian M, Mousavi SA, Abedi SM, JafariSarouei M, Gooran M, Balmeh P, et al. Comparison of early surgical and conservative therapy in children with ureteropelvic junction obstruction. *Pediatr Surg Int*. 2023 Dec 1;39(1). doi:10.1007/S00383-023-05434-W PubMed PMID: 36879145.

3. Dong J, Wong J, Al-Enezi A, Kapoor A, Whelan JP, Piercey K, et al. Laparoscopic pyeloplasty: the updated McMaster University experience. *Canadian Urological Association Journal*. 2008;2(4):388. doi:10.5489/CUAJ.806 PubMed PMID: 18781214.
4. Lopez PJ, Calvillo-Ramirez A, Sancaktutar A, Yankovic F, Moldes JM, Corbetta JP, et al. Redo Laparoscopic Pyeloplasty in Children: Results from a Multicentric Series. *International Brazilian Journal of Urology : Official Journal of the Brazilian Society of Urology*. 2025;51(5):e20250077. doi:10.1590/S1677-5538.IBJU.2025.0077 PubMed PMID: 40513021.
5. Szyduczyński M, Korneliussen J, Jażdżewska A, Sosińska D, Wojciechowska E, Anzelewicz S, et al. Comparative Outcomes of Robot-Assisted and Laparoscopic Pyeloplasty in Infants and Toddlers: A Systematic Review and Meta-Analysis. *Children*. 2026 Jun 1;13(6):728. doi:10.3390/CHILDREN13060728/S1
6. Yang JW, Wang L, Wu Z, Wang KY, Li KP, Wan S, et al. Single-port robot-assisted pyeloplasty versus multiport pyeloplasty: evidence from controlled trials. *J Robot Surg*. 2025 Dec 1;19(1). doi:10.1007/S11701-025-02251-2 PubMed PMID: 40016552.
7. Singh P, Dogra PN, Kumar R, Gupta NP, Nayak B, Seth A. Outcomes of robot-assisted laparoscopic pyeloplasty in children: a single center experience. *J Endourol*. 2012 Mar 1;26(3):249–53. doi:10.1089/END.2011.0350 PubMed PMID: 22191495.
8. He Z, Li J, Zhang Y, Xiao C, Zhong W, Qiu J, et al. Comparison of the treatment effect of laparoscopic and robot-assisted single-port laparoscopic pyeloplasty on ureteropelvic junction obstruction in infants. *J Robot Surg*. 2025 Dec 1;19(1). doi:10.1007/S11701-025-02528-6 PubMed PMID: 40618311.
9. Kang SK, Jang WS, Kim SH, Kim SW, Han SW, Lee YS. Comparison of intraoperative and short-term postoperative outcomes between robot-assisted laparoscopic multi-port pyeloplasty using the da Vinci Si system and single-port pyeloplasty using the da Vinci SP system in children. *Investig Clin Urol*. 2021 Sep 1;62(5):592–9. doi:10.4111/ICU.20200569 PubMed PMID: 34387035.
10. Avery DI, Herbst KW, Lendvay TS, Noh PH, Dangle P, Gundeti MS, et al. Robot-assisted laparoscopic pyeloplasty: Multi-institutional experience in infants. *J Pediatr Urol*. 2015 Jun 1;11(3):139.e1-139.e5. doi:10.1016/j.jpuro.2014.11.025 PubMed PMID: 26052000.
11. Neheman A, Kord E, Zisman A, Darawsha AE, Noh PH. Comparison of Robotic Pyeloplasty and Standard Laparoscopic Pyeloplasty in Infants: A Bi-Institutional Study. *J Laparoendosc Adv Surg Tech A*. 2018 Apr 1;28(4):467–70. doi:10.1089/LAP.2017.0262 PubMed PMID: 29206567.
12. Chen J, Xu H, Lin S, He S, Tang K, Xiao Z, et al. Robot-assisted pyeloplasty and laparoscopic pyeloplasty in children: A comparison of single-port-plus-one and multiport surgery. *Front Pediatr*. 2022 Oct 21;10:957790. doi:10.3389/FPED.2022.957790/TEXT