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Robotic-Assisted Pyeloplasty Using the da Vinci Surgical Systems compared to Laparoscopic or Open Approach: A systematic Literature Review and Meta-analysis

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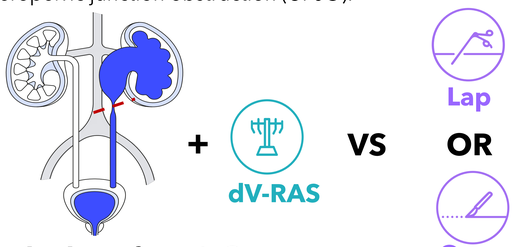
INTRODUCTION

- Despite increasing adoption of robotic-assisted surgery with da Vinci surgical system (dV-RAS), comparative evidence versus laparoscopic and open surgery remains limited and fragmented, with most studies limited by small sample sizes and inconsistent outcome reporting.
- There is a need for a comprehensive synthesis of the available evidence evaluating perioperative and quality of life outcomes in benign ureteropelvic junction obstruction management.

AIM

This systematic review and meta-analysis compared perioperative and quality-of-life outcomes following dV-RAS, Lap, and open pyeloplasty for the treatment of benign ureteropelvic junction obstruction (UPJO).



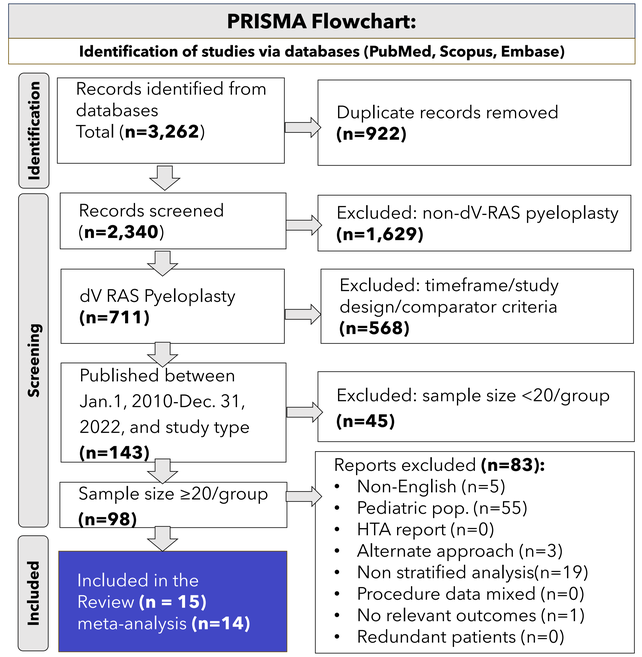
METHODS

- A PRISMA-guided review and meta-analysis comparing dV-RAS to Lap or Open pyeloplasty, identified through PubMed, Embase, and Scopus searches over 14 years.

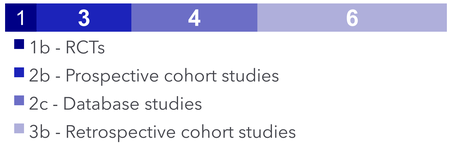
P	Adults undergoing pyeloplasty for UPJO
I	dV-RAS pyeloplasty
C	Lap and open pyeloplasty
O	*Clinical outcomes*: conversion rate, crossing vessels, operative time, blood transfusions, length of hospital stay, intraoperative complications, 30-day Outcomes (postoperative complications, surgical site infections, reoperations, readmissions, mortality), time to drain removal, success rate, recurrence rate. *Quality of life outcomes*: pain medication use (analgesics/opioids) and Visual Analog Score (VAS) pain score within 30 days of surgery, return to work (RTW), return to Activities of Daily Living (ADL)
T	January 1, 2010 - December 31, 2024
S	Randomized controlled trials, prospective, database and retrospective cohort studies with sample size >20 in each cohort
	P: Population; I: Intervention; C: Comparator; O: Outcomes; T: Timeframe; S: Study design

- Meta-analysis was conducted in R (Meta package). A random model was used for heterogeneity of I^2>50%.

RESULTS



- ***14 publications*** on pyeloplasty for UPJO
  - **9,140** dV-RAS patients
  - **13,632** Lap patients
  - **30,701** Open patients
- ***Level of Evidence (No. studies)***



- ***Geographic distribution (No. studies)***
  - **United States/Canada** 8 (57%)
  - **Pan-Asia** 5 (36%)
  - **Europe** 1 (7%)

Table 1: Meta-analysis results: Benign Pyeloplasty

	Outcome	No. of studies	dV-RAS (n)	Comparator (n)	Effect size	p-value	Heterogeneity
dV-RAS vs Lap	Crossing vessels (%)†	6	372	267	OR: 1.16 [0.83, 1.63]	0.38	I^2 = 19.97%; p=0.28
	Conversions to open surgery (%)	5	338	233	OR: 0.25 [0.03, 2.45]	0.23	I^2 = 0%; p=0.82
	Operative time (min)	8	887	571	MD: -15.9 [-45.4, 13.6]	0.29	I^2 = 95.03%; p<0.01*
	Intraoperative complications (%)	4	646	411	OR: 0.94 [0.35, 2.53]	0.91	I^2 = 0%; p=0.57
	Length of hospital stay (days)	9	8393	13190	MD: -0.43 [-1.81, 0.95]	0.54	I^2 = 98.96%; p<0.01*
	30-day complications (%)	5	741	475	OR: 0.75 [0.45, 1.22]	0.24	I^2 = 0%; p=0.77
	Success rate (%)◊	6	352	253	OR: 1.68 [0.77, 3.69]	0.20	I^2 = 0%; p=0.94
	Activities of daily living (days)	2	59	59	MD: -1.75 [-4.89, 1.38]	0.27	I^2 = 88.56%; p=0.003*
	Time to drain removal (days)	4	233	169	MD: -0.2 [-0.42, 0.03]	0.09	I^2 = 0%; p=0.41
	Pain at 30-day follow up (VAS)	2	63	63	MD: -0.11 [-0.3, 0.08]	0.26	I^2 = 0%; p=0.70
	Recurrence of obstruction (%)	2	64	64	OR: 0.66 [0.11, 4.06]	0.65	I^2 = 0%; p=0.70
	30-day mortality (%)	2	7310	12865	RD: 0.0003 [-0.0004, 0.0009]	0.45	I^2 = 0%; p=0.97
dV-RAS vs Open	Crossing vessels (%)†	3	107	112	OR: 1.90 [1.08, 3.36]	**0.03**	I^2 = 0%; p=0.46
	Operative time (min)	3	107	112	MD: 8.06 [-0.21, 16.34]	0.06	I^2 = 2.62%; p=0.36
	Blood transfusions (%)	2	6921	28829	RD: -0.0185 [-0.0217, -0.0153]	**<0.01**	I^2 = 0%; p=0.39
	Intraoperative complications (%)	2	77	82	RD: -0.0119 [-0.0524, 0.0287]	0.57	I^2 = 0%; p=0.61
	Length of hospital stay	6	8196	30701	MD: -1.88 [-2.87, -0.89]	**<0.01**	I^2 = 99.49%; p<0.01*
	30-day complications (%)	2	73	78	OR: 0.26 [0.11, 0.60]	**<0.01**	I^2 = 0%; p=0.43
	Success rate (%)◊	2	73	78	OR: 2.51 [0.75, 8.44]	0.14	I^2 = 0%; p=0.86
	Time to drain removal (days)	2	64	64	MD: -1.17 [-1.71, -0.62]	**<0.01**	I^2 = 0%; p=0.37
	Pain at 30-day follow up (VAS)	2	77	82	MD: -551.03 [-1769.23, 667.16]	0.38	I^2 = 79.88%; p=0.03*
	Recurrence of obstruction (%)	2	64	64	OR: 0.66 [0.11, 4.06]	0.65	I^2 = 0%; p=0.70
	30-day mortality (%)	2	7310	29828	RD: -0.0006 [-0.0013, 0.0001]	0.10	I^2 = 0%; p=0.74

Bold values are statistical significance, P < 0.05; Inverse Variance (IV) Fixed model used for all the outcomes EXCEPT those denoted by (*) for which random model was used. Outcomes not reported in this table had insufficient data.
†Crossing vessels: accessory renal vessels crossing the UPJ causing extrinsic compression/obstruction.
◊Success rate: Surgical success after pyeloplasty was defined as improvement in hydronephrosis and/or symptom resolution during follow-up without the need for secondary intervention due to re-stenosis.

RESULTS

Compared to Open, patients undergoing dV-RAS had:

- ↑ Prevalence of crossing vessels by **90%**
- ↓ **Fewer** blood transfusions
- ↓ Length of stay by average **1.88 days**
- ↓ 30-day postoperative complications by **74%**
- ↓ Time to drain removal by **1.17 days**

CONCLUSIONS

- When compared to open approach dV-RAS treated more cross vessel patients, had fewer blood transfusions, 30-day postoperative complications, shorter length of hospital stay and time to drain removal supporting favorable perioperative recovery despite potentially greater case complexity.
- Our review and analysis suggest that da Vinci robotic-assisted pyeloplasty is comparable with laparoscopic approach.
- Future research should incorporate validated quality-of-life instruments, pain assessments, return-to-activity measures, and long-term recurrence and renal functional outcomes to strengthen the evidence base for benign UPJO management.

TABLES & REFERENCES

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