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ROBOTIC-ASSISTED SURGERY WITH THE DA VINCI SURGICAL SYSTEMS COMPARED TO LAPAROSCOPIC OR OPEN VENTRAL HERNIA REPAIR: A SYSTEMATIC LITERATURE REVIEW AND META-ANALYSIS

A. Yankovsky [1], **N. Patel** [1], **U. Kreaden**[1]

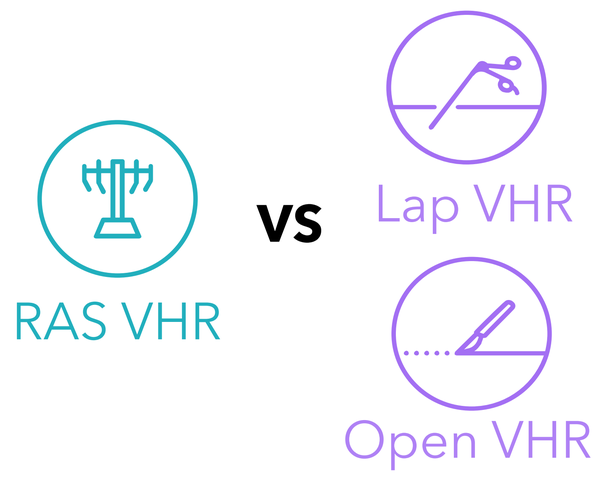
[1]Intuitive Surgical, Sunnyvale, California, USA. Contact information: Ana.Yankovsky@intusurg.com

INTRODUCTION

- Ventral hernia has a significant impact on patient health and quality of life.
- **Ventral hernia repair (VHR)** is the surgical procedure to repair the abdominal wall defect.
- The use of **robot-assisted surgery (RAS)** has been increasing as an alternative to a **laparoscopic (LAP)** or **open** surgical approach.

AIM

This systematic literature review and meta-analysis assesses the clinical and patient value of RAS compared to LAP or open surgery for VHR.

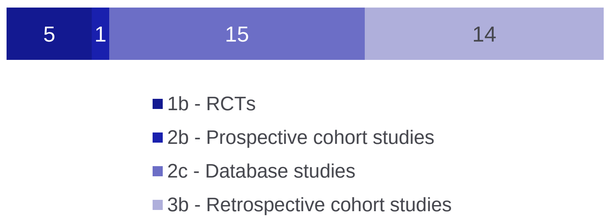


METHODS

- A search of PubMed, Embase, and Scopus databases was conducted between January 1, 2010 and March 1, 2024 for studies comparing RAS, LAP, and open VHR.
- Publications were excluded for the following: if not in English, pediatric cases, mixed procedures or study arms, no relevant outcomes, or redundant data.
- Outcomes assessed were operative time, conversions, hospital stay, postoperative complications, pain, reoperations, readmissions, hernia recurrence, quality of life, and 30-day mortality.

RESULTS

- **35 publications** including:
  - Robotic-assisted patients: **17,118**
  - Laparoscopic patients: **152,210**
  - Open patients: **156,376**



- **Compared to LAP**, patients undergoing RAS ventral hernia repair with da Vinci surgical system had:
  - ↑ Operative time by **59 minutes**
  - ↓ Conversions by **46%**
  - ↓ 30-day surgical site infection by **56%**
  - ↓ 30-day pain scores (VAS) by **0.8 points**
  - ↓ 2-year hernia recurrence by **87%**
  - All other outcomes were comparable
- **Compared to open**, patients undergoing RAS ventral hernia repair with da Vinci surgical system had:
  - ↑ Operative time by **93 minutes**
  - ↓ Length of hospital stay by **2.6 days**
  - ↓ 30-day surgical site infection by **72%**
  - ↓ 30-day readmissions by **29%**
  - ↓ 30-day hernia recurrence by **84%**
  - ↓ Risk of 30-day mortality
  - All other outcomes were comparable

Table 1: Study characteristics

Study ID	Country	Study type	Study period	VHR Repair Type	No. of patients		
					RAS	Lap	Open
Alteri 2018	USA	DB	2010 - 2013	NS	679	20896	
Armijo 2017	USA	DB	Jan 2013 - Sep 2015	NS	465	6829	39505
Ayuso 2021	USA	DB	2016 – 2018	NS	5942	19853	
Bittner 2017	USA	RETRO	Jan 2, 2015 - Aug 30, 2016	R-TAR, O-TAR	26		76
Carbonell 2017	USA	DB	2010 - 2016	Retro-muscular mesh technique	111		222
Chen 2016	USA	RETRO	Jul 2013 - Jul 2015	Intraperitoneal onlay of the mesh	39	33	
Christoffersen 2022	Denmark	RETRO	Lap: 01 Dec 2017 – 01 Dec 2018 RAS: 01 Mar 2021 – 01 Jun 2021	Retrorectus or IPOM	27	32	
Coakley 2017	USA	DB	2008 - 2013	NS	351	32243	
Collins 2021	USA	DB	2013 – 2020	Retromuscular mesh technique	433		1695
Dewulf 2022	Belgium, Finland	RETRO	Belgium: Dec 2011 – Oct 2019 Finland: Aug 2017 – May 2021	R-TAR, O-TAR	90		79
Dhanani 2021	USA	RCT	April 2018 - Feb 2019	TAR	65	59	
Dhanani 2023	USA	RCT	Apr 2018 – Feb 2019	TAR	54	47	
Forester 2020	USA	RETRO	2009 - 2019	O-TAR, L-intraperitoneal underlay, R-TAR	77	300	418
Gaskins 2023	USA	DB	NR	Retromuscular mesh technique	253		664
Gonzalez 2014	USA	RETRO	Nov 2009 - Aug 2012	Primary closure. NPCD-mesh reinforced with transabdominal sutures	67	67	
Guzman-Pruneda 2020	USA	DB	2013 - 2019	Retromuscular mesh technique	42		194
Hennessey 2023	Canada	RETRO	Jan 2020 – Aug 2022	NS	28		45
Henriksen 2023	Denmark	DB	01 Jan 2017 – 22 Aug 2022	NS	528		1521
Howard 2023	USA	DB	01 Jan 2007 – 31 Dec 2015	NS	2444	29131	109686
Khorgami 2018	USA	DB	2012 - 2014	NS	99	3600	
Kushner 2021	USA	RETRO	Jan 2017 - Dec 2020	R-TAR, O-TAR	109		212
LaPinska 2020	USA	DB	Jul 2013 - Dec 2016	NS	615	615	
LeBlanc 2021	USA	PRO	2016 - 2020	Repair without myofascial release	159	82	130
Lu 2019	USA	RETRO	Sep 2015 - May 2018	R- eTEP, L-eTEP	86	120	
Martin-Del-Campo 2017	USA	RETRO	Apr 2015 - Dec 2016	R-TAR, O-TAR	38		76
Mehaffey 2017	USA	RETRO	Jan 1, 2011 - Dec 31, 2015	Any VHR	254	158	
Olavarria 2020	USA	RCT	Apr 2019 - Feb 2019	Intraperitoneal onlay mesh placement	65	59	
Pereira 2022	USA	DB	Jan 2013 – Jan 2021	Lateral hernia repairs (subcostal, flank, iliac, and lumbar)	758		1811
Petro 2020	USA	RCT	Sep 2017 - Jan 2020	Intraperitoneal access and adhesiolysis	39	36	
Petro 2022	USA	RCT	Sep 2017 – Jan 2020	Intraperitoneal access and adhesiolysis	38	33	
Plitzko 2023	Germany	RETRO	RAS: Apr – Nov 2022 Lap/Open: Jan 2018 – Nov 2022	Retromuscular or pre-peritoneal mesh repair	21	19	42
Prabhu 2017	USA	DB	2013 - 2016	R-IPOM, L-IPOM	177	454	
Shah 2022	USA	DB	01 Jan 2013 – 30 Sep 2015	NS	2744	37368	
Walker 2018	USA	RETRO	2009 - 2015	Intraperitoneal underlay	142	73	
Warren 2016	USA	RETRO	Jun 2013 - May 2015	R-TAR, Lap-intraperitoneal, preperitoneal, retromuscular access and adhesiolysis	53	103	

RCT –Randomized controlled trial; PRO – prospective cohort study; DB – large database study; RETRO – retrospective cohort study; R-robotic; L-laparoscopic; O-open; TAR-Transversus abdominis release; TEP-Extended totally extraperitoneal; IPOM-Intraperitoneal onlay mesh repair; NS- not specified

Table 2: Meta-analysis results

Outcome	Comparison	# Studies	RAS N	LAP/ Open N	Weighted Effect Size	Effect p-value	Heterogeneity	Model	Conclusion
Operative time (min)	RAS vs LAP	10	754	904	MD = 58.82 [39.55, 78.08]	<0.01	$p < 0.01$; $I^2 = 91\%$	Random	Favors LAP
	RAS vs Open	7	439	748	MD = 92.79 [39.26, 146.32]	<0.01	$p < 0.01$; $I^2 = 96\%$	Random	Favors open
Conversions to open (%)	RAS vs LAP	6	3703	38293	OR = 0.54 [0.44, 0.66]	<0.01	$p = 0.44$; $I^2 = 0\%$	Fixed	Favors RAS
	RAS vs Open	Not relevant							
Blood transfusions (%)	RAS vs LAP	No data							
	RAS vs Open	One study Martin-Del-Campo 2017 R=0%, O=6.57%, p=0.106							
Length of hospital stay (days)	RAS vs LAP	16	7677	77094	MD = -0.20 [0.62, 0.22]	0.35	$p < 0.01$; $I^2 = 96\%$	Random	No difference
	RAS vs Open	13	2600	43732	MD = -2.57 [-3.23, -1.91]	<0.01	$p < 0.01$; $I^2 = 95\%$	Random	Favors RAS
Postoperative complications 30-days (%)	RAS vs LAP	10	2320	9111	OR = 0.72 [0.46, 1.12]	0.15	$p < 0.01$; $I^2 = 78\%$	Random	No difference
	RAS vs Open	9	1891	41674	OR = 0.69 [0.49, 0.96]	0.05	$p < 0.01$; $I^2 = 63\%$	Random	No difference
Reoperations 30-days (%)	RAS vs LAP	10	1283	1764	OR = 0.48 [0.23, 1.02]	0.06	$p = 0.81$; $I^2 = 0\%$	Fixed	No difference
	RAS vs Open	7	1286	1882	OR = 0.62 [0.35, 1.09]	0.1	$p = 0.85$; $I^2 = 0\%$	Fixed	No difference
Readmissions 30-days (%)	RAS vs LAP	11	2797	28975	OR = 0.94 [0.59, 1.49]	0.79	$p = 0.01$; $I^2 = 55\%$	Random	No difference
	RAS vs Open	12	2343	42549	OR = 0.71 [0.56, 0.90]	<0.01	$p = 0.40$; $I^2 = 5\%$	Fixed	Favors RAS
Mortality 30-days (%)	RAS vs LAP	7	6339	51920	OR = 0.95 [0.57, 1.58]	0.84	$p = 0.47$; $I^2 = 0\%$	Fixed	No difference
	RAS vs Open	10	1836	41663	RD = -0.0084 [-0.0135, -0.0034]	<0.01	$p = 0.91$; $I^2 = 0\%$	Fixed	Favors RAS
Emergency room visit 30-days (%)	RAS vs LAP	4	2949	20164	OR = 0.99 [0.58, 1.68]	0.97	$p = 0.05$; $I^2 = 61\%$	Random	No difference
	RAS vs Open	One study Forester 2020 R=6.5%, O=10.3%, p=0.1421							
Surgical Site Infection 30-day (%)	RAS vs LAP	9	1054	1233	OR = 0.44 [0.21, 0.92]	0.03	$p = 0.55$; $I^2 = 0\%$	Fixed	Favors RAS
	RAS vs Open	9	1693	2836	OR = 0.28 [0.18, 0.44]	<0.01	$p = 0.65$; $I^2 = 0\%$	Fixed	Favors RAS
Postoperative pain 30-days (VAS score)	RAS vs LAP	2	103	94	MD = -0.80 [-1.40, -0.20]	<0.01	$p = 0.19$; $I^2 = 41\%$	Fixed	Favors RAS
	RAS vs Open	One study VAS Score at discharge and 6 mon. One study PROMIS Score. One paper 90-day pain requiring readmission							
Postoperative pain medication use at discharge (%)	RAS vs LAP	2	624	6911	OR = 0.72 [0.50, 1.03]	0.07	$p = 0.27$; $I^2 = 16\%$	Fixed	No difference
	RAS vs Open	2	624	39635	OR = 0.76 [0.46, 1.26]	0.29	$p = 0.14$; $I^2 = 54\%$	Random	No difference
Return to work (days)	RAS vs LAP	2	236	382	MD = -1.50 [-6.98, 3.98]	0.59	$p < 0.01$; $I^2 = 94\%$	Random	No difference
	RAS vs Open	2	236	548	MD = -1.58 [-7.07, 3.90]	0.57	$p < 0.01$; $I^2 = 95\%$	Random	No difference
Quality of life 30-days (HerQLes Score)	RAS vs LAP	2	198	118	MD = -0.27 [-6.61, 6.06]	0.93	$p = 0.16$; $I^2 = 49\%$	Fixed	No difference
	RAS vs Open	3	866	989	MD = -1.98 [-4.82, 0.86]	0.17	$p = 0.18$; $I^2 = 41\%$	Fixed	No difference
Hernia recurrence 30-days (%)	RAS vs LAP	4	335	468	RD = -0.0205 [-0.0606, 0.0195]	0.32	$p < 0.01$; $I^2 = 75\%$	Random	No difference
	RAS vs Open	3	901	1213	OR = 0.16 [0.03, 0.95]	0.04	$p = 0.82$; $I^2 = 0\%$	Fixed	Favors RAS
Hernia recurrence 90-days (%)	RAS vs LAP	3	293	251	RD = 0.0014 [-0.0294, 0.0322]	0.93	$p = 0.90$; $I^2 = 0\%$	Fixed	No difference
	RAS vs Open	One study Belyansky 2017 R=0%, O=0%							
Hernia recurrence 1-year (%)	RAS vs LAP	One study Petro 2022 R=23%, L=6%, p=0.04							
	RAS vs Open	One study Guzman-Pruneda 2020 R=24%, O=20%, p=0.54.							
Hernia recurrence 2-years (%)	RAS vs LAP	2	121	114	OR = 0.23 [0.06, 0.85]	0.03	$p = 0.81$; $I^2 = 0\%$	Fixed	Favors RAS
	RAS vs Open	One study Dewulf 2022 R=5.6%, O=5.1%, p>0.9							

CONCLUSION

Our study demonstrates that using the da Vinci surgical system/s for VHR results in many benefits to the patient, including lower rates of surgical site infection, fewer conversions to open surgery when compared to Lap, less pain, shorter length of hospital stay when compared to open surgery, and lower rates of hernia recurrence. Additional research is needed on patient recovery and quality of life.

REFERENCES

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