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Research Article

Robotic-Assisted Surgery versus Conventional Laparoscopic Surgery: A Comprehensive Comparative Analysis of Perioperative, Oncologic, Functional, and Economic Outcomes Across Surgical Specialties

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ABSTRACT

Background: Robotic-assisted surgery (RAS) has expanded rapidly across nearly every surgical subspecialty since its introduction, marketed on the premise of superior dexterity, three-dimensional visualization, and ergonomic advantage over conventional laparoscopic surgery (LS). Whether these theoretical advantages translate into superior patient-centered outcomes remains contested, particularly given the substantially higher costs and longer operative times consistently associated with RAS.

Objective: To synthesize contemporary comparative evidence, prioritizing randomized controlled trials (RCTs) and high-quality meta-analyses published through 2026, on perioperative, oncologic, functional, and economic outcomes of RAS versus LS across colorectal, urologic, gynecologic, bariatric, and hernia surgery.

Methods: A structured narrative review of the literature indexed in PubMed, Embase, Scopus, and the Cochrane Library was performed, with priority given to RCTs, PRISMA-compliant systematic reviews and meta-analyses, and large national registry (MBSAQIP-derived and similar) analyses published between 2012 and 2026. Outcomes of interest included operative time, estimated blood loss, conversion to open surgery, length of hospital stay (LOS), complication rates (graded by the Clavien–Dindo classification where available), oncologic adequacy (lymph node yield, resection margins), functional recovery (continence, potency, quality of life), cost, and the surgeon learning curve.

Results: Across specialties, RAS was consistently associated with longer operative time and higher direct cost than LS, with cost differentials ranging from roughly $1,800 to over $10,000 per case depending on procedure and health system. Complication rates were generally comparable between approaches in high-quality RCTs. RAS demonstrated a modest but statistically significant reduction in length of stay in colorectal and gynecologic procedures, lower conversion rates in colorectal and obese-patient subgroups, and improved short-term (3-6 month) functional recovery after radical prostatectomy, though these functional differences frequently attenuated by 12 months. In inguinal hernia repair, three RCTs found no clinically meaningful advantage of RAS over LS. Learning-curve data suggest that proficiency thresholds (roughly 15–50 cases depending on procedure complexity) meaningfully influence reported outcomes, and many existing comparative studies were conducted during the robotic learning phase, potentially underestimating the platform's true capability.

Conclusion: Current level-1 evidence supports general equivalence between RAS and LS for most perioperative and complication outcomes, with RAS offering selective, procedure-specific advantages (reduced conversion in technically demanding anatomy, modestly shorter LOS, and faster short-term functional recovery in prostatectomy) at consistently higher cost and longer operative time. Widespread adoption of RAS should be guided by procedure-specific evidence, institutional volume, and cost-effectiveness analysis rather than by technology adoption alone. Adequately powered RCTs with long-term oncologic follow-up and standardized economic reporting remain a priority.

Keywords: Robotic-assisted surgery, laparoscopic surgery, minimally invasive surgery, surgical outcomes, da Vinci surgical system, cost-effectiveness, learning curve, comparative effectiveness research

1. INTRODUCTION

Minimally invasive surgery has fundamentally reshaped operative practice since the introduction of laparoscopy in the 1980s, reducing wound-related morbidity, hospital stay, and convalescence relative to open surgery. Robotic-assisted surgery (RAS) emerged as a further technological evolution of the minimally invasive paradigm, offering surgeons three-dimensional stereoscopic vision, articulated wristed instrumentation with seven degrees of freedom, tremor filtration, and improved ergonomics compared with rigid-instrument laparoscopy.[1,2] Since the U.S. Food and Drug Administration approval of the da Vinci Surgical System, robotic platforms have been adopted across nearly every surgical subspecialty, and newer competitor platforms-including Versius and Hugo RAS-have entered the market with claims of improved cost-effectiveness and shorter training requirements.[2]

Despite this rapid diffusion, whether RAS produces outcomes that are meaningfully superior to conventional laparoscopic surgery (LS) remains a matter of active investigation and debate. Early comparative literature was dominated by retrospective, single-institution cohort studies vulnerable to selection bias, learning-curve confounding, and industry-sponsored reporting. Over the past decade, however, a growing body of randomized controlled trials (RCTs) and large multi-institutional registry analyses has allowed for more rigorous comparison. This review synthesizes that evidence across the five surgical domains in which RAS has achieved the greatest clinical penetration-colorectal surgery, urologic (prostate) surgery, gynecologic surgery, bariatric and upper gastrointestinal surgery, and hernia repair-and considers the economic and training implications of robotic adoption.

2. METHODS

This is a structured narrative review rather than a formal systematic review with meta-analysis; it is intended to synthesize and contextualize existing high-quality systematic reviews, meta-analyses, and RCTs rather than to pool patient-level or study-level data de novo. A literature search was conducted across PubMed/MEDLINE, Embase, Scopus, and the Cochrane Central Register of Controlled Trials for studies published between January 2012 and January 2026, using combinations of the search terms "robotic," "robot-assisted," "laparoscopic" and specialty-or procedure-specific terms (e.g., "colorectal", "prostatectomy", "hysterectomy", "sleeve gastrectomy", "gastric bypass", "inguinal hernia", "ventral hernia"). Priority was given to RCTs, PRISMA-compliant systematic reviews and meta-analyses (particularly those restricted to RCT-level evidence and assessed using GRADE methodology), and large national or multicenter registry analyses (e.g., MBSAQIP). Narrative summaries, single-arm case series, and studies lacking a laparoscopic comparator were deprioritized. Outcomes of interest were operative time, estimated blood loss, conversion to open surgery, length of hospital stay, 30-day and Clavien-Dindo-graded complications, oncologic outcomes (lymph node yield, margin status, recurrence where reported), procedure-specific functional outcomes (urinary continence and erectile function after prostatectomy; weight loss after bariatric surgery), direct and indirect cost, and surgeon learning-curve metrics.

3. RESULTS

3.1 COLORECTAL SURGERY

Colorectal surgery has been among the most extensively studied domains for RAS-versus-LS comparison. A 2024 systematic review and meta-analysis focused on colon cancer resections performed between 2020 and 2024 compared operative time, length of stay, conversion rate, complication rate, anastomotic leak rate, and lymph node harvest between the two approaches, reflecting the multidimensional nature of the comparison in oncologic colorectal surgery.[3] A 2025 meta-analysis restricted exclusively to RCTs (searched from January 2000 through December 2025) similarly prioritized conversion to open surgery, operative time, and blood loss as primary outcomes, with length of stay, Clavien-Dindo grade ≥III complications, and pathological metrics as secondary outcomes, reflecting an effort to isolate RAS's genuine technical advantages-superior visualization and dexterity-from confounding introduced by non-randomized designs.[4]

In colorectal cancer patients with obesity, a population in which the technical challenges of laparoscopic pelvic dissection are magnified, a meta-analysis of six studies comprising 4,215 patients found that RAS was associated with a statistically significant, though modest, reduction in hospital stay compared with LS.[5] A large 2025 PRISMA-compliant, PROSPERO-registered re-analysis of RCTs published between 2015 and 2025 provided some of the most granular outcome data available: operative time was consistently longer with RAS, by a mean difference of approximately 24 minutes (95% CI 14.2-33.4; I^2=67%); overall postoperative complications (Clavien-Dindo ≥II) were statistically comparable between groups; length of stay was modestly but significantly shorter with RAS (mean difference approximately 0.8 days); circumferential resection margin positivity was significantly lower with RAS; and lymph node retrieval was marginally higher with RAS. Notably, no included RCT reported mature long-term oncologic survival data, meaning current evidence remains limited to short-term surrogate endpoints.[6]

For rectal cancer specifically-where pelvic anatomy poses particular technical difficulty for laparoscopic total mesorectal excision-a large meta-analysis incorporating 56 studies and 25,458 patients evaluated operative time, blood loss, lymph node harvest, conversion rate, postoperative hospital stay, survival to discharge, urinary retention, and anastomotic leakage, underscoring the breadth of outcomes considered clinically relevant in this anatomically challenging setting.[7] A recurring caveat across the colorectal literature concerns the learning curve: the landmark ROLARR trial, often cited as showing no significant difference between robotic and laparoscopic rectal cancer surgery, required only ten prior robotic cases as a competency threshold for participating surgeons, while laparoscopic-arm surgeons were, by comparison, already established experts-a design limitation that may have underestimated the platform's ceiling performance.[8]

3.2 UROLOGIC SURGERY: RADICAL PROSTATECTOMY

Robotic-assisted radical prostatectomy (RARP) has become the dominant approach to surgical management of localized prostate cancer in many health systems, and the urologic literature includes some of the highest-quality RCT evidence available anywhere in the RAS-versus-LS comparison. The multicentre, randomized, patient-blinded LAP-01 trial, conducted across four hospitals in Germany, randomized patients 3:1 to RARP or conventional laparoscopic radical prostatectomy (LRP) and initially demonstrated superiority of RARP for continence at three months.[9,10] At twelve-month follow-up (701 of 782 randomized patients), continence remained numerically better in the RARP group but was no longer statistically significant (p=0.068 at six months; p=0.38 at twelve months), suggesting that the functional advantage of RAS, where present, may be concentrated in the early postoperative recovery window rather than representing a durable long-term difference.[9]

A comprehensive systematic review and meta-analysis that separately pooled RCT and non-randomized evidence (46 articles; 4 from 3 RCTs and 42 non-randomized studies) concluded that RARP was associated with improved functional outcomes relative to LRP, along with potential-though less certain-advantages in perioperative and oncologic outcomes.[11] A more recent RCT-restricted meta-analysis with individual-patient data pooling (1,205 randomized patients) found no significant difference in continence at 12 months (OR 1.95, 95% CI 0.67-5.62) but did identify significant early advantages favoring RARP at 3 and 6 months. For potency, patients who were potent at baseline and underwent robot-assisted nerve-sparing prostatectomy were significantly more likely to remain potent at 12 months than their laparoscopic counterparts (OR 4.05, 95% CI 1.63-10.09).[12] A 2025 GRADE-assessed meta-analysis with geographic subgroup analysis, incorporating trials through October 2025, further examined 12-month continence and erectile function as co-primary outcomes, reflecting the field's move toward more rigorous, subgroup-sensitive evidence synthesis.[13] Complementary meta-analytic work has also isolated erectile function specifically as an outcome of interest, again distinguishing RCT from non-randomized evidence to guard against confounding.[15] Earlier evidence, including a 2019 meta-analysis comparing RARP, LRP, and open radical prostatectomy, situated the robotic-versus-laparoscopic comparison within the broader context of minimally invasive versus open approaches, generally favoring minimally invasive techniques of either type over open surgery for perioperative morbidity.[16]

3.3 GYNECOLOGIC SURGERY: HYSTERECTOMY

Hysterectomy is among the most common major gynecologic operations worldwide, and robotic hysterectomy (RH) achieved rapid, and at times controversial, adoption following FDA approval of the da Vinci platform, despite an evidence base that has not consistently demonstrated clinical superiority over conventional laparoscopic hysterectomy (CLH).[17] A systematic review comparing operating time, estimated blood loss, length of hospitalization, complications, survival, and cost found that outcomes were generally comparable between RH and CLH, with the principal and most consistent difference being cost: RH was significantly more expensive than CLH, driven by capital equipment costs, disposable instrumentation, maintenance, and sterilization requirements.[17] This cost differential was corroborated by a large U.S. cohort study, which found robotically assisted hysterectomy conferred little short-term clinical benefit over laparoscopic hysterectomy for benign gynecologic disease while costing approximately $2,189 more per case,[19] and by an analysis of abdominal, vaginal, laparoscopic, and robotic hysterectomy costs, which found mean total costs of $49,526 for robotic hysterectomy compared with $38,312 for laparoscopic hysterectomy, without a significant difference in complication rates.[20]

Nonetheless, a 2026 RCT-only, GRADE-assessed systematic review and meta-analysis-the first to synthesize exclusively randomized evidence for benign hysterectomy with comprehensive certainty-of-evidence grading-found that robotic and conventional laparoscopic hysterectomy produced comparable operative outcomes, with the robotic approach offering a modest but measurable reduction in hospitalization duration, while reiterating that the substantial cost differential remains a central consideration for adoption decisions.[21] Notably, the technical advantages of RAS-improved ergonomics, three-dimensional visualization, wristed instrument mobility, and platform stability-appear most clinically relevant in specific patient subsets, particularly obesity and large uterine weight (>750 g).[17] A cost and outcomes analysis stratified by uterine weight found that for uteri exceeding 1,000 g, the laparoscopic approach required substantially longer operative time than the robotic approach (mean difference approximately 81 minutes), a difference associated with an incremental cost of approximately $1,859 favoring the time-efficiency of the robotic platform in this technically demanding subgroup, even though robotic hysterectomy remains more expensive overall for average-complexity cases.[22] For gynecologic malignancy, a systematic review comparing laparoscopic hysterectomy, robotic-assisted hysterectomy, and laparoscopic-assisted vaginal hysterectomy in uterine and cervical cancer found both minimally invasive approaches to be viable, lower-complication alternatives to open surgery, with the specific choice between them best individualized to patient and disease characteristics pending further confirmatory oncologic safety data.[23] Broader analyses of cost-effectiveness in gynecologic robotic surgery emphasize that institutional case volume is a key determinant of value: high-volume centers with multidisciplinary robotic teams achieve more favorable economic balance than low-volume institutions, though this creates a risk of geographic inequity in access to robotic gynecologic oncology care.[24]

3.4 BARIATRIC AND UPPER GASTROINTESTINAL SURGERY

In metabolic and bariatric surgery, robotic sleeve gastrectomy (RSG) and robotic Roux-en-Y gastric bypass (RYGB) have been compared with their laparoscopic counterparts (LSG and LRYGB) in a series of meta-analyses and large registry studies. A meta-analysis of 21 studies published between 2011 and 2024 found that weight-loss efficacy was similar between RSG and LSG, but RSG was associated with a significantly longer operative duration-a weighted mean difference of approximately

27.5 minutes.[26] An earlier, smaller meta-analysis of four studies (3,599 sleeve gastrectomy cases, comprising 280 robotic and 3,319 laparoscopic) found RSG associated with modestly more favorable body mass index at one year, alongside significantly longer operative time, with no significant differences in leak rate, perioperative bleeding, stricture formation, or length of stay.[27]

Large national registry data provide additional, higher-volume perspective. Analysis of the MBSAQIP database, encompassing 823,902 primary sleeve gastrectomy and gastric bypass cases from 2015-2022, was used to benchmark robotic against laparoscopic 30-day outcomes following propensity-score matching.[25] A related global-benchmarking study published in the British Journal of Surgery similarly found that robotic sleeve gastrectomy outperformed laparoscopic sleeve gastrectomy across most surgical outcome measures, with comparable operative duration in high-volume, benchmark-achieving centers-though centers still within their robotic learning phase only met established quality benchmarks for lower-risk cases, again underscoring the importance of the learning curve in interpreting comparative outcomes.[28] In the specific context of revisional bariatric surgery-generally more technically demanding than primary procedures-an 8-year MBSAQIP analysis of over 40,000 revisional cases found that the robotic approach was associated with lower 30-day postoperative morbidity and shorter length of stay compared with laparoscopic revisional gastric bypass.[29] A separate MBSAQIP analysis spanning 2015-2021 and including nearly 1.2 million bariatric procedures concluded that robotic and laparoscopic approaches produced clinically comparable outcomes across sleeve gastrectomy, duodenal switch, and gastric bypass when analyzed at national scale.[30]

For gastric cancer surgery, an umbrella review of fourteen meta-analyses (through December 2019) found that robotic gastrectomy was associated with longer operative time but reduced intraoperative blood loss, shorter hospital stay, and more rapid return of bowel function compared with laparoscopic gastrectomy; lymph node yield and distal resection margin were superior with robotic surgery in analyses reaching statistical significance, while total complication rate, mortality, morbidity, anastomotic leak, anastomotic stenosis, intestinal obstruction, and conversion rate did not differ significantly between approaches.[31]

3.5 HERNIA REPAIR

Hernia repair represents the domain in which the highest-quality RCT evidence has most consistently failed to demonstrate a clinical advantage for RAS over LS. The RIVAL trial, the first randomized comparison of robotic and laparoscopic transabdominal preperitoneal (TAPP) inguinal hernia repair, randomized 113 patients (102 analyzed) across six academic centers and found no significant differences at 30 days in postoperative pain, health-related quality of life, mobility, wound morbidity, or cosmesis between approaches; the robotic approach was associated with increased operative time, increased cost, and greater surgeon-reported frustration, without discernible ergonomic benefit.[32] One-and two-year follow-up of the same trial cohort confirmed that laparoscopic and robotic inguinal hernia repair produced similar long-term outcomes when performed by surgeons experienced in minimally invasive technique.[33]

A subsequent systematic review and meta-analysis restricted to RCTs of robotic versus laparoscopic TAPP repair (three trials, 300 patients, literature search through September 2025) found that operative time was longer with the robotic approach, though the difference did not reach statistical significance (mean difference +17.6 minutes, 95% CI −20.7 to 55.9, p=0.37), and complication rates were statistically similar between groups.[34] The more recent ROGER trial, a Swiss single-center, patient-and investigator-blinded RCT of 182 patients comparing laparoscopic totally extraperitoneal (TEP) repair with robotic TAPP, found no significant difference in the primary outcome of postoperative pain while coughing at 24 hours (median 5 vs. 4 on a numeric rating scale, p=0.431), while operative time was again significantly longer for the robotic arm (mean 80.3 vs. 64.2 minutes, p<0.001) and complication rates were similar (10% vs. 11%). Notably, surgeon-reported workload, measured using the NASA Task Load Index, was significantly lower for the robotic approach despite its longer duration, suggesting a genuine ergonomic benefit for the operating surgeon even in the absence of a measurable patient-centered advantage.[35] For ventral hernia repair, registry-based studies have suggested that robotic repair may reduce length of stay relative to laparoscopic repair, but these findings derive from observational data subject to substantial selection bias; among randomized trials specifically designed to test this question, none to date have demonstrated a clinical benefit of the robotic approach over laparoscopic repair.[36]

3.6 COST, LEARNING CURVE AND HEALTH-SYSTEM CONSIDERATIONS

A consistent theme across every surgical domain reviewed is that RAS carries materially higher direct costs than LS, driven by capital acquisition costs (a single robotic system typically costs well over a million dollars), annual maintenance contracts, and per-case disposable instrumentation.[17,20,40] Illustrative of the broader capital-cost barrier, even lower-cost articulated laparoscopic instrument systems marketed as robotic alternatives carry acquisition costs in the range of $120,000-$140,000 with substantial per-procedure costs, underscoring that cost pressure is a structural feature of robotic-adjacent technology generally, not merely of the flagship da Vinci platform.[40]

The surgeon learning curve represents a second recurring confounder in comparative outcome studies. A systematic review of 26 studies on the learning curve in robotic general surgery found that the number of cases required to reach plateau performance varied substantially by procedure: approximately 19-128 cases for colorectal surgery, 8-95 for foregut/bariatric surgery, 20-48 for biliary surgery, and 10-80 for solid organ surgery, with many studies identifying multiple distinct learning-curve phases as surgeons progressively incorporated more complex cases.[37] A broader systematic review of learning curves across robot-assisted surgery more generally concluded that although learning curves are widely reported, methodological heterogeneity and inconsistent reporting introduce considerable uncertainty into these estimates, limiting their direct use in training program design.[38] A five-year Australian case series tracking four surgeons new to robotic general surgery (303 cases: 193 colorectal, 110 hernia) found that the learning curve, as measured by docking time, plateaued after approximately two years or 12-15 cases, with length of stay decreasing as surgeon experience accumulated-evidence that early-adoption outcomes likely understate the platform's steady-state performance.[39] This has direct implications for interpreting comparative trials: the ROLARR colorectal trial, for example, required robotic-arm surgeons to have completed only ten prior cases, a threshold well below most plateau estimates, raising the possibility that its null result understated RAS's achievable benefit once surgeons are fully proficient.[8] Conversely, proponents note that the robotic platform's improved visualization and articulated instrumentation may itself shorten the learning curve relative to conventional laparoscopy for surgeons transitioning from open surgery, potentially expanding minimally invasive access in lower-volume settings once the initial capital and training barriers are overcome.[2,41]

Table No. 1: Summary of Comparative Outcomes Between Robotic-Assisted Surgery (RAS) and Laparoscopic Surgery (LS) by Specialty

Specialty/Procedure	Operative Time	Length of Stay	Complications	Cost	Conversion Rate
Colorectal resection (colon/rectal cancer)	Longer with RAS (~+24 min)	Modestly shorter with RAS (~0.8 d)	Comparable (Clavien-Dindo ≥II)	Higher with RAS	Lower with RAS
Radical prostatectomy	Comparable to longer with RAS	Comparable	Comparable; functional recovery favors RAS short-term	Higher with RAS	Rarely applicable
Hysterectomy (benign disease)	Comparable to shorter with RAS	Modestly shorter with RAS	Comparable	Higher with RAS (~$1,800-2,200 more)	Lower with RAS in large uteri
Bariatric surgery (SG/RYGB)	Longer with RAS (~+27 min, primary cases)	Comparable	Comparable primary; lower with RAS in revisional cases	Higher with RAS	Comparable to lower with RAS
Inguinal/ventral hernia repair	Longer with RAS	Comparable	Comparable	Higher with RAS	Comparable

Note: Directional summaries reflect the weighted pattern of findings across the cited systematic reviews, meta-analyses, and RCTs for each domain [3–41] and should not be interpreted as pooled effect estimates; magnitude and statistical significance vary by procedure, patient population, and study design.

4. DISCUSSION

The accumulated evidence reviewed here supports a nuanced conclusion: robotic-assisted surgery is neither the categorical advance its early proponents suggested nor the cost-inflating redundancy its critics sometimes allege, but rather a platform whose value is highly procedure-and context-dependent. Across nearly all specialties examined, RAS is associated with longer operative time and substantially higher direct cost than LS-findings so consistent across colorectal,[4,6] gynecologic,[17,19,20] bariatric,[26,27] and hernia surgery[32,34,35] that they can reasonably be regarded as an intrinsic and durable feature of the current robotic paradigm rather than an artifact of early-adoption inefficiency.

Against this consistent cost and time penalty, RAS's demonstrated advantages are real but selective. In colorectal surgery, the reduction in conversion rate and modest reduction in length of stay are most pronounced in technically demanding anatomy-obese patients and narrow pelvic dissections-where the robotic platform's superior visualization and articulated dissection plausibly confer genuine technical benefit.[5,7] In radical prostatectomy, the LAP-01 trial's finding of an early but non-durable continence advantage, together with meta-analytic evidence of improved potency preservation in nerve-sparing procedures, suggests that RAS's dexterity advantage is most clinically meaningful in anatomically delicate, function-preserving dissection near the neurovascular bundle.[9,12] In benign gynecologic and bariatric surgery-procedures with less anatomically constrained dissection planes-the incremental clinical benefit of RAS over LS is smaller and less consistent, while the cost differential remains essentially unchanged, yielding a less favorable value proposition.[17,21,26] Hernia repair represents the clearest case in which high-quality RCT evidence (RIVAL, ROGER, and the pooled TAPP meta-analysis) has failed to demonstrate a patient-centered advantage for RAS, even as it has identified a genuine reduction in surgeon-reported physical and cognitive workload-a benefit to the surgical workforce that current outcome frameworks, focused overwhelmingly on patient-centered endpoints, may systematically undervalue.[32,34,35]

The learning curve confound deserves particular emphasis. Because case-volume thresholds for plateau robotic performance are substantial (often 15-50+ cases depending on procedure complexity),[37,39] and because several influential RCTs-including ROLARR-enrolled robotic-arm surgeons at case volumes below these thresholds while comparator laparoscopic surgeons were established experts,[8] existing trial evidence may systematically understate RAS's achievable ceiling. Future comparative trials should report and, where possible, control for surgeon case volume on both study arms, and post-marketing registry studies should stratify outcomes by institutional and individual surgeon experience to disentangle platform effects from proficiency effects.

From a health-systems perspective, the consistent cost premium associated with RAS raises important resource-allocation questions, particularly in low- and middle-income settings and in health systems with capacity constraints, where the opportunity cost of robotic capital investment may exceed its marginal clinical benefit for many procedures.[24,40] Value-based adoption frameworks-prioritizing robotic deployment for procedures and patient subgroups with the clearest demonstrated benefit (e.g., complex pelvic dissection, high-BMI patients, revisional bariatric surgery) rather than blanket institutional adoption-may represent a more defensible path forward than platform-wide substitution of RAS for LS.[22,29]

5. LIMITATIONS

This review has several limitations inherent to its narrative design. First, it synthesizes existing systematic reviews and meta-analyses rather than performing de novo patient-level pooling, and therefore inherits any risk of bias, publication bias, or heterogeneity present in the underlying primary literature. Second, the pace of publication in this field is rapid, and several syntheses cited here are themselves recent preprints or 2025-2026 publications that have not yet undergone extended post-publication scrutiny; findings should be interpreted as provisional pending further replication. Third, cost data are highly heterogeneous across health systems, reimbursement models, and countries, limiting the generalizability of specific dollar-figure comparisons cited from U.S.-based studies to other settings. Fourth, long-term oncologic outcomes (5- and 10-year survival, recurrence) remain immature or unreported in most RCTs comparing RAS and LS for cancer surgery, meaning current conclusions are necessarily limited to short- and medium-term surrogate endpoints. Finally, because industry funding and physician training incentives are pervasive in this literature, formal risk-of-bias and conflict-of-interest assessment of each primary source-while performed within the cited systematic reviews themselves-was not independently re-verified for this narrative synthesis.

6. CONCLUSION

Robotic-assisted surgery and conventional laparoscopic surgery produce broadly comparable complication and safety profiles across the specialties reviewed, with robotic surgery consistently requiring longer operative time and higher direct cost. Meaningful, procedure-specific advantages of RAS-reduced conversion in technically demanding dissections, modestly shorter hospital stay, and improved short-term functional recovery after prostatectomy-are real but selective rather than universal, and are most defensible in anatomically challenging or high-BMI cases and in revisional surgery. Adoption decisions should therefore be guided by procedure-specific, RCT-level evidence, institutional case volume, and formal cost-effectiveness analysis, rather than by the assumption that robotic assistance is categorically superior to laparoscopy. Priority areas for future research include adequately powered RCTs with mature long-term oncologic follow-up, standardized and transparent economic reporting across health systems, and learning-curve-adjusted comparative analyses that more fairly isolate the platform's achievable clinical ceiling from surgeon inexperience.

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DATA AVAILABILITY: All data supporting this review are available within the cited published sources.

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