Journal of
Clinical Medicine

MDPI

Review

Robotic Gastrointestinal Surgery Compared to Conventional Approaches: An Umbrella Review of Clinical and Economic Outcomes

Seung Hyun Rho [1,†], Jeonghyun Lee [2,†] and Jun Suh Lee [3,*]

[1] Department of Medicine, Yonsei University College of Medicine, Seoul 03722, Republic of Korea
[2] Department of Medicine, Catholic University College of Medicine, Seoul 06591, Republic of Korea
[3] Department of Surgery, Bucheon Sejong Hospital, Bucheon 14754, Republic of Korea
[*] Correspondence: rudestock@gmail.com; Tel.: +82-10-2747-6320
[†] These authors contributed equally to this work.

Abstract

Background/Objectives: Robotic-assisted surgery (RAS) has emerged as a technological advancement in gastrointestinal (GI) procedures, addressing limitations of conventional laparoscopy through enhanced dexterity, three-dimensional visualization, and ergonomic improvements. While its clinical use is expanding, the comparative benefits and cost-effectiveness of RAS across different GI domains remain unclear. **Methods:** An umbrella review was conducted to evaluate RAS across six GI domains: esophageal, gastric, liver, biliary, pancreatic, and colorectal. A systematic literature search of PubMed was performed in April 2025, yielding 8961 articles. Reviews published in English since 2018 and comparing RAS with laparoscopic or open approaches in human GI surgery were eligible. A total of 250 articles met the inclusion criteria. Data on technical feasibility, clinical outcomes, and cost-effectiveness were extracted. Methodological quality was appraised using the AMSTAR 2 checklist. Results were synthesized narratively. The study was supported by the National Research Foundation of Korea grant, and the protocol was registered in PROSPERO (CRD420251042541). **Results:** RAS demonstrated domain-specific advantages. Esophageal and gastric surgeries benefited from enhanced precision and lymphadenectomy, while long-term outcomes were comparable to laparoscopy. Robotic liver and biliary surgeries offered technical advantages in complex cases, but evidence was limited. The most significant clinical benefits were observed in pancreatic and colorectal procedures, in which RAS reduced conversion rates and improved short-term outcomes in anatomically challenging scenarios. Cost-effectiveness was generally unfavorable but showed improvement in high-volume centers due to reduced complications and shorter hospital stays. **Conclusions:** Robotic assistance provides the most consistent clinical benefit in pancreatic and colorectal surgery, especially for complex, high-risk cases. While high procedural costs remain a barrier, selective use of RAS in appropriate settings may yield improved outcomes. These findings support the need for ongoing evaluation of cost-effectiveness and long-term results to guide evidence-based integration of robotics into GI surgery.

Keywords: robotic surgery; gastrointestinal procedures; surgical outcome; cost-benefit analysis; minimally invasive surgical procedures

check for updates

Academic Editor: Roberto Cirocchi

Received: 17 October 2025
Revised: 25 November 2025
Accepted: 1 December 2025
Published: 2 December 2025

Citation: Rho, S.H.; Lee, J.; Lee, J.S. Robotic Gastrointestinal Surgery Compared to Conventional Approaches: An Umbrella Review of Clinical and Economic Outcomes. *J. Clin. Med.* **2025**, *14*, 8555. https://doi.org/10.3390/jcm14238555

1. Introduction

Minimally invasive surgery (MIS) has transformed gastrointestinal (GI) surgery by reducing morbidity, shortening hospital stays, and improving recovery. However, conventional laparoscopy is limited by two-dimensional visualization, restricted instrument movement, and ergonomic strain on surgeons [1]. Robotic-assisted surgery (RAS), developed to overcome these limitations, offers enhanced dexterity, three-dimensional imaging, and improved ergonomics, facilitating complex GI procedures in confined anatomical spaces [2].

While robotic surgery was initially dominated by urological and gynecologic applications, recent trends show a rapid expansion into GI procedures. Gastric, liver, pancreatic and colorectal surgeries now represent a substantial and growing proportion of robotic cases worldwide, particularly in cancer-focused institutions. Since receiving FDA approval, robotic systems have been increasingly adopted in GI oncology.

More recently, the single-port (SP) system has allowed all instruments to be deployed through a single 2.5 cm incision using a specialized cannula, improving access in confined anatomical spaces such as the deep pelvis or retroperitoneum [3,4].

Although da Vinci remains the most widely used platform, other robotic systems, such as Senhance, Hugo, and Versius, have also emerged, expanding the landscape of robotic GI surgery. Evidence from multicenter reviews and meta-analyses suggests that robotic surgery leads to reduced conversion rates, blood loss, and postoperative complications compared to laparoscopic and open approaches [5].

Despite these clinical benefits, the high cost of robotic platforms remains controversial [6]. While some argue these expenses are justified by better outcomes and shorter hospital stays [5], others contend that current evidence is insufficient to justify widespread adoption [7]. This umbrella review compares robotic and conventional approaches across six GI domains—esophageal, gastric, liver, biliary, pancreatic, and colorectal—evaluating clinical outcomes and cost-effectiveness with the ultimate goal of identifying which procedures derive the greatest benefit from robotic assistance. In the existing literature, robotic surgery has been compared to both laparoscopic and open approaches, often within the same review. Because umbrella reviews synthesize data from previously published systematic reviews and meta-analyses, the comparator definitions follow those used in the included reviews. Therefore, in this study, the term ‘conventional approaches’ refers to laparoscopic and/or open surgery, depending on the comparator used in each individual review. The heterogeneity of comparators is acknowledged and discussed as an intrinsic methodological limitation of umbrella reviews.

2. Materials and Methods

2.1. Search Strategy

A comprehensive literature search was conducted in the PubMed (12 April 2025) database. Gastrointestinal procedures were categorized into six domains: esophageal, gastric, liver, biliary, pancreatic, and colorectal surgery. For each domain, relevant studies were identified using combinations of search terms related to robotic surgery, conventional surgical approaches, and domain-specific procedures; the full search strategies are provided in Supplementary Table S1. This umbrella review protocol was registered in PROSPERO (No. CRD420251042541) and is available at: https://www.crd.york.ac.uk/PROSPERO/view/CRD (accessed on 24 November 2025). The registered protocol outlines the objectives, eligibility criteria, search strategy, and planned data synthesis methods of this review.

The literature search was performed exclusively in PubMed. For each gastrointestinal domain, we used predefined keyword combinations including terms such as ‘robotic surgery’, ‘laparoscopic’, ‘open’, ‘esophagectomy’, ‘gastrectomy’, ‘hepatectomy’, ‘biliary surgery', 'pancreatectomy', and 'colorectal resection.' Detailed domain-specific search strings (e.g., "robotic AND esophagectomy", "robotic gastrectomy AND laparoscopy", "robotic hepatectomy AND open") are provided in Supplementary Table S1.

2.2. Eligibility Criteria

Articles published after January 2018 were selected for this study. During our systematic search, we observed a substantial increase in publications related to robotic gastrointestinal surgery beginning in 2018. To ensure clinical relevance and capture recent advancements in surgical robotics, we limited inclusion to articles published within this timeframe. Eligible study types included meta-analyses, systematic reviews, and narrative reviews. Only human studies published in English were included. We selected reviews that evaluated the clinical performance of robotic surgery compared to conventional (laparoscopic or open) approaches. Reviews covering multiple or unrelated surgical sites were excluded.

2.3. Screening and Data Extraction

Two independent researchers screened all records for relevance based on titles and abstracts. Full-text articles of potentially eligible studies were assessed against the predefined inclusion and exclusion criteria. Any discrepancies between reviewers were resolved through discussion and consensus. For all eligible publications, data were manually extracted into standardized tables, including details on surgical domain, procedure type, surgical approach, and key findings. A full quality control check of the extracted data was conducted by two researchers to ensure accuracy and completeness.

Comparators were classified as 'conventional approaches', a term that reflects the definitions used in the included reviews. These comparators included laparoscopic and/or open surgery depending on the scope of each review. Because umbrella reviews synthesize previously published reviews rather than re-analyzing primary data, comparator heterogeneity could not be standardized across domains.

2.4. Methodological Quality Assessment

To assess the methodological rigor of the included reviews, the AMSTAR 2 (A Measurement Tool to Assess Systematic Reviews 2) checklist was applied. This tool evaluates the quality of systematic reviews based on 16 critical and non-critical domains, and assigns an overall confidence rating (high, moderate, low, or critically low) in the validity of each review's findings. All assessments were performed independently by two reviewers, and discrepancies were resolved by consensus.

To assess the degree of overlap among included systematic reviews, we calculated the Corrected Covered Area (CCA), a validated metric quantifying the frequency of shared primary studies across reviews [8]. The CCA quantifies the percentage of overlapping primary studies across reviews, accounting for both the number of reviews and the number of unique studies. A CCA of 0–5% was interpreted as slight overlap, 6–10% as moderate, 11–15% as high, and >15% as very high overlap. This review followed PRISMA 2020 guidelines; the completed checklist is provided in Supplementary Tables S2 and S3.

3. Results

3.1. Study Selection

A total of 8961 articles were initially identified through the systematic literature search. After restricting the publication period to studies published between 2018 and 2025, 6200 articles remained. Following the application of eligibility criteria based on article type, 4871 studies were excluded. An additional 56 non-English articles were removed.

Subsequently, 920 articles involving human subjects were selected for further screening. After reviewing titles and abstracts, 670 articles were excluded due to irrelevance to the study topic, leaving 250 articles selected for full-text review. Of these, 25 studies focused on esophageal surgery [5,9–32], 44 on gastric surgery [33–76], 33 on liver surgery [77–109], 30 on biliary surgery [110–139], 40 on pancreatic surgery [6,140–177], and 78 on colorectal surgery [178–254] (Figure 1).

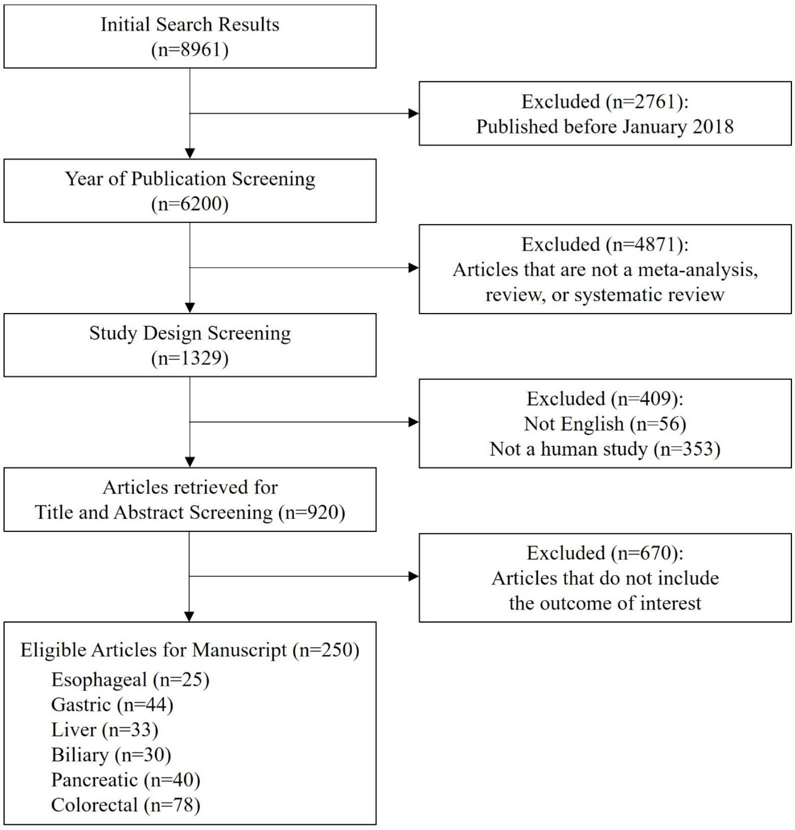


Figure 1. Flow diagram of the study selection process.

A detailed summary of all included reviews, including study characteristics and key findings, is provided in Supplementary Table S6.

3.2. Methodological Quality Assessment

Among the 250 included systematic reviews, 73 (29.2%) were rated as having high methodological quality, 65 (26.0%) as moderate, 57 (22.8%) as low, and 55 (22.0%) as critically low, based on the AMSTAR 2 tool (Supplementary Table S4). To evaluate the degree of overlap among included reviews, we calculated the CCA for each gastrointestinal surgical domain. The CCA values for esophageal (8.97%), gastric (6.81%), and liver (8.93%) domains indicated moderate overlap. In contrast, the biliary (0.61%), pancreatic (0.02%), and colorectal (0.01%) domains demonstrated slight overlap (Supplementary Table S5). These findings suggest that while redundancy among primary studies was modest in the upper gastrointestinal domains, it was minimal in the lower gastrointestinal and hepatobiliary categories. The quality assessment for each domain is provided in Table 1, and a detailed summary of the general characteristics and key findings of each included article is presented in Supplementary Table S6.

Table 1. Quality assessment of the studies included in each surgical domain.

Domain	Number of Reviews	AMSTAR 2 Evaluation	CCA Value (%)	Overlap Level
Esophageal	25	High: 10, Moderate: 0, Low: 4, Critically low: 11	8.97%	Moderate
Gastric	44	High: 0, Moderate: 30, Low: 10, Critically low: 4	6.81%	Moderate
Liver	33	High: 16, Moderate: 11, Low: 1, Critically low: 5	8.93%	Moderate
Biliary	30	High: 5, Moderate: 0, Low: 9, Critically low: 16	0.61%	Slight
Pancreatic	40	High: 15, Moderate: 2, Low: 14, Critically low: 9	0.02%	Slight
Colorectal	78	High: 27, Moderate: 22, Low: 19, Critically low: 10	0.01%	Slight

AMSTAR 2: A Measurement Tool to Assess Systematic Reviews 2; CCA: Corrected Covered Area.

3.3. Esophageal Surgery

Robotic esophageal surgery encompasses a wide range of techniques (McKeown, Ivor Lewis, and Heller myotomy), and the included reviews differed substantially in how deeply they analyzed each approach. This variation in procedural focus contributes to heterogeneity in the reported short-term and oncologic outcomes.

3.3.1. Technical Considerations

Robotic surgery in esophageal procedures offers unique technical advantages over laparoscopic approaches, particularly in the confined mediastinal space. The rigid, straight laparoscopic instruments limit maneuverability during critical steps such as lymphadenectomy near the recurrent laryngeal nerve and thoracic duct dissection. In contrast, robotic systems provide wristed instrumentation and stable 3D visualization, facilitating fine dissection and improved access, especially in the upper mediastinum during esophagectomy [9–11]. These benefits are particularly evident in complex procedures such as the McKeown and Ivor Lewis esophagectomies. The McKeown approach (Figure 2) involves three surgical fields—abdominal, thoracic, and cervical—with a cervical anastomosis that allows for extended lymphadenectomy but carries a higher risk of recurrent laryngeal nerve injury [255]. The Ivor Lewis approach, by contrast, is a two-field technique with an intrathoracic anastomosis, offering lower anastomotic stricture rates but posing greater risk if a leak occurs. Robotic platforms enhance precision during these procedures, particularly in esophagogastric anastomosis and lymph node retrieval, contributing to oncologic adequacy [12]. However, robotic esophagectomy often requires redocking during two-field procedures and may involve a steeper learning curve. While robotic stapling and hand-sewn techniques are increasingly used, the lack of tactile feedback remains a technical challenge during high-tension suturing or dissection near vascular structures [9].

Although the Versius system is shown here as an example of emerging robotic platforms (Figure 3), it is important to note that its use in esophageal surgery remains limited. Most of the evidence included in this umbrella review is based on the da Vinci multi-port systems (Figure 4), which currently dominate robotic esophagectomy. The inclusion of Versius reflects the scope of the reviewed literature rather than any direct comparison of platform performance.

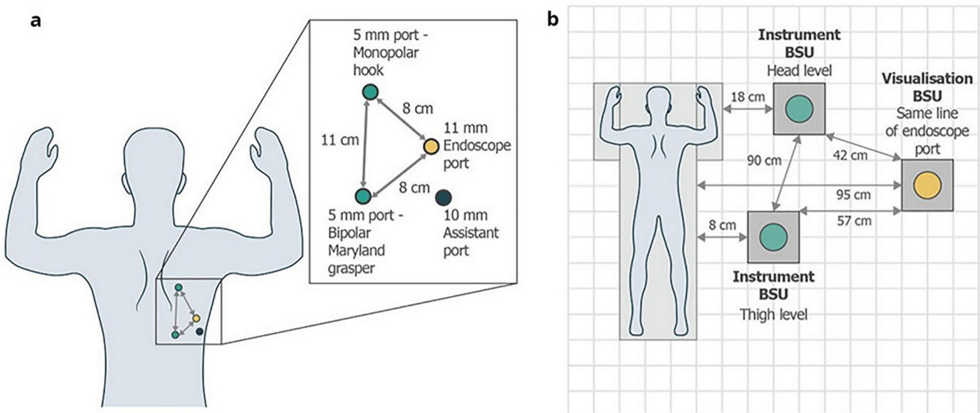


Figure 2. Port positioning and operating room layout. (**a**) Port positioning for TTE and (**b**) corresponding BSU positions. The TTE was a minimal access McKeown's procedure with cervical esophagogastric anastomosis, performed using a three-hole approach. An 11 mm endoscope port was placed in the 5th or 6th intercostal space. The right 5 mm instrument port was placed approximately in the 3rd intercostal space. The left 5 mm instrument port was placed in the 7th–8th intercostal space. One 10 mm assistant port was placed between the left instrument port and the endoscope port. BSU: bedside unit, TTE: transthoracic esophagectomy. Reproduced from [Puntambekar et al., Sci Rep, 2022 [255]] under the terms of the Creative Commons Attribution 4.0 International License (http://creativecommons.org/licenses/by/4.0/).

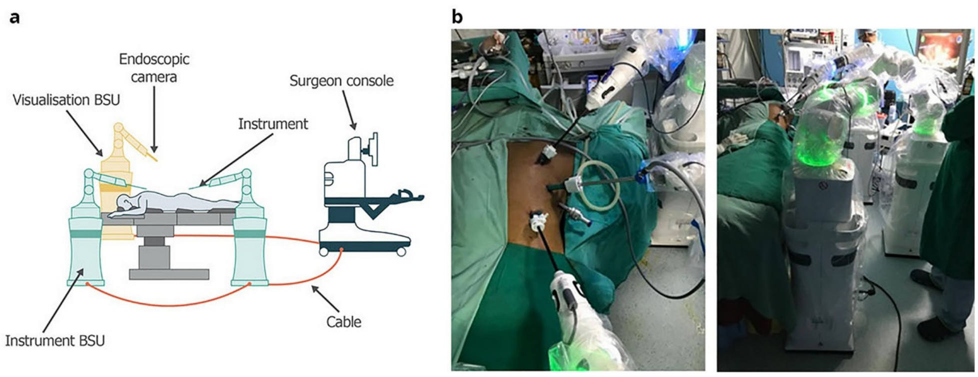


Figure 3. Overview of the Versius Surgical System. Adapted from Haig et al. (**a**) Schematic representation of the setup of Versius and (**b**) real-world images of the Versius setup. BSU: bedside unit. Reproduced from [Puntambekar et al., Sci Rep, 2022 [255]] under the terms of the Creative Commons Attribution 4.0 International License (http://creativecommons.org/licenses/by/4.0/).

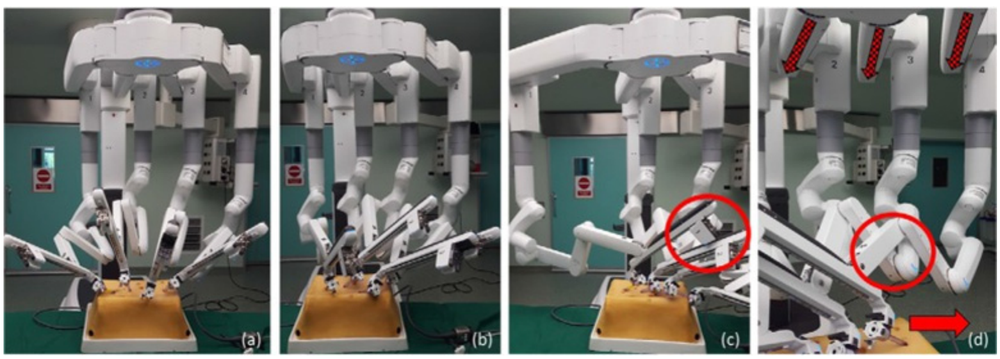


Figure 4. The da Vinci Xi robotic system. (**a**) FLEX joints should be compacted, leaving one-fist-width spacing between each robotic arm (**b**) to allow the robotic arms to move in parallel. (**c**) The instrument carriage tends to clash with the adjacent arm (circle) when the FLEX joints are spaced apart. (**d**) The

robotic arms also clash (circle) when the operative target (solid arrow) lies outside of the FLEX joint alignment (dotted arrows). Reproduced from [Ngu et al., RSRR, 2017 [3]] under the terms of the Creative Commons Attribution—NonCommercial (unported, v3.0) License (http://creativecommons.org/licenses/by-nc/3.0/).

3.3.2. Advantages and Limitations

Robotic-assisted minimally invasive esophagectomy (RAMIE) has shown favorable short-term outcomes compared to laparoscopic techniques, including reduced intraoperative blood loss, lower incidence of recurrent laryngeal nerve injury, and fewer pulmonary complications [10,12]. In Heller myotomy for achalasia, the robotic approach is associated with lower rates of mucosal injury and improved postoperative dysphagia scores [5]. Lymph node yield also tends to be higher in RAMIE, reflecting improved precision during mediastinal dissection [13,14]. However, RAMIE is limited by longer operative times, increased setup complexity, and the absence of haptic feedback [9,15]. These challenges can be especially pronounced in patients with obesity or complex mediastinal anatomy. Importantly, long-term oncologic outcomes, including survival and recurrence rates, appear comparable between robotic and laparoscopic approaches [13,16].

3.3.3. Cost-Effectiveness

Despite improved perioperative outcomes, robotic esophagectomy remains more costly than laparoscopic approaches due to the high capital expense of robotic systems, longer operative times, and specialized instrumentation [17,18]. However, in complex cases such as redo surgery or paraesophageal hernia repair, robotic assistance may reduce healthcare costs associated with postoperative complications and overall hospitalization, thereby partially offsetting the initial investment [19,20]. Therefore, while RAMIE may not be cost-effective for routine cases, its value increases in technically demanding scenarios.

3.4. Gastric Surgery

Gastric surgery represents one of the most heterogeneous domains in robotic GI surgery, with differences in distal versus total gastrectomy, D2 lymphadenectomy, and reconstruction techniques. The included reviews vary considerably in the depth of analysis across these subprocedures, which explains the diversity in reported outcomes.

3.4.1. Technical Considerations

Gastric cancer surgery often requires extensive lymphadenectomy and precise anastomosis within a confined space. While laparoscopic gastrectomy has been widely adopted, it remains technically challenging for D2 lymph node dissection and intracorporeal reconstruction [33]. Robotic gastrectomy provides greater articulation through wristed instruments, allowing for improved maneuverability around major vessels such as the left gastric artery and splenic hilum [34–36]. Additionally, the robotic platform facilitates suturing during intracorporeal Billroth I/II or Roux-en-Y reconstruction (Figure 5), especially in high BMI patients or those with visceral obesity [37–39,256]. The stable camera platform and 3D visualization enhance the precision of perigastric dissection, contributing to better lymph node yield and fewer vascular injuries [40]. However, robotic systems also introduce limitations such as increased setup time, limited haptic feedback, and instrument clashing in narrow pelvic anatomy [39–41].

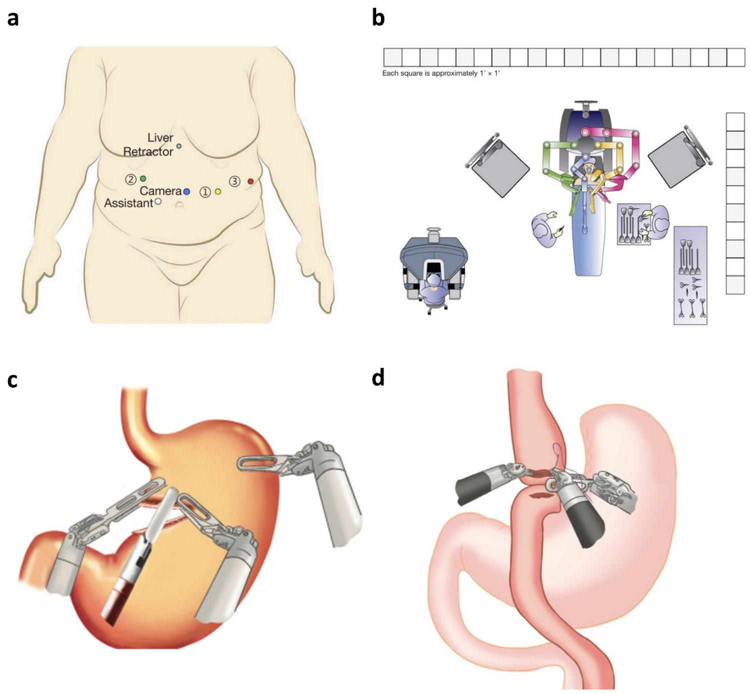


Figure 5. Robotic Roux-en-Y gastric bypass. (**a**) Port position in robotic gastric bypass. (**b**) Operating room setup and patient cart positioning for robot-assisted Roux-en-Y gastric bypass (RYGB). (**c**) Sketch diagram showing horizontal stapler fire for formation of gastric pouch. (**d**) Sketch diagram showing creation of the gastrojejunostomy (GJ). A hand-sewn GJ is being created. The third arm is holding the gastric pouch and Roux limb together. Reproduced from [Bindal et al., Dig Med Res, 2021 [256]] under the terms of the Creative Commons Attribution—NonCommercial—NoDerivatives 4.0 International License (https://creativecommons.org/licenses/by-nc-nd/4.0/).

3.4.2. Advantages and Limitations

Robotic gastrectomy (RG) is associated with significantly reduced intraoperative blood loss, lower conversion rates, and fewer postoperative complications compared to laparoscopic gastrectomy (LG) [42,43]. These advantages are most apparent in technically demanding situations, particularly in cases requiring D2 lymphadenectomy, where robotic assistance enables more precise dissection and yields higher lymph node retrieval without increasing operative morbidity [36,44]. The oncologic importance of achieving an adequate D2 lymphadenectomy has been repeatedly emphasized, and several studies suggest that robotic systems may facilitate more consistent nodal dissection due to improved visualization and instrument dexterity [45]. RG has also demonstrated reduced pancreatic fistula rates in overweight patients and may offer additional functional benefits, such as improved gastric conduit preservation [46].

Despite these advantages, RG is associated with longer operative times and a prolonged learning curve, particularly for total gastrectomy. Furthermore, several studies report no significant difference in long-term oncologic outcomes—such as recurrence or overall survival—between RG and LG [40,47].

3.4.3. Cost-Effectiveness

Robotic gastrectomy entails higher upfront costs related to robotic system acquisition, maintenance, and disposable instrumentation. Studies have shown that RG increases operative cost compared to LG by approximately 1.3–1.7 times [41,48,49]. However, this may be partially offset by fewer complications, lower readmission rates, and shorter recovery time in high-risk or obese patients [33,50]. Despite these potential benefits, cost-effectiveness remains limited in standard-risk patients undergoing routine gastrectomy.

3.5. Liver Surgery

Robotic liver resection covers a broad spectrum of procedures, from minor hepatectomy to major posterosuperior segmentectomy and bile duct reconstruction. The included reviews reflect this procedural diversity, leading to variability in the emphasis placed on technical complexity and perioperative outcomes.

3.5.1. Technical Considerations

Liver resection presents specific challenges related to vascular control, parenchymal transection, and access to posterosuperior segments. Laparoscopic liver surgery often relies on the Cavitron Ultrasonic Surgical Aspirator (CUSA) for precise parenchymal dissection, which cannot be directly controlled by the robotic console. Instead, robotic systems utilize alternative tools such as bipolar forceps or vessel sealers, often requiring bedside assistant coordination [77–79]. The robotic approach, however, provides enhanced access to difficult segments (VII and VIII) due to wristed instruments and improved ergonomics [80–82]. Robotic visualization also facilitates fine suturing in bile duct reconstructions and hepaticojejunostomies, although the lack of haptic feedback may pose risks during deep dissection or vascular clipping [77,83–85]. Moreover, robotic resections (Figures 6 and 7) require careful port placement and repositioning when switching between hepatic lobes [257].

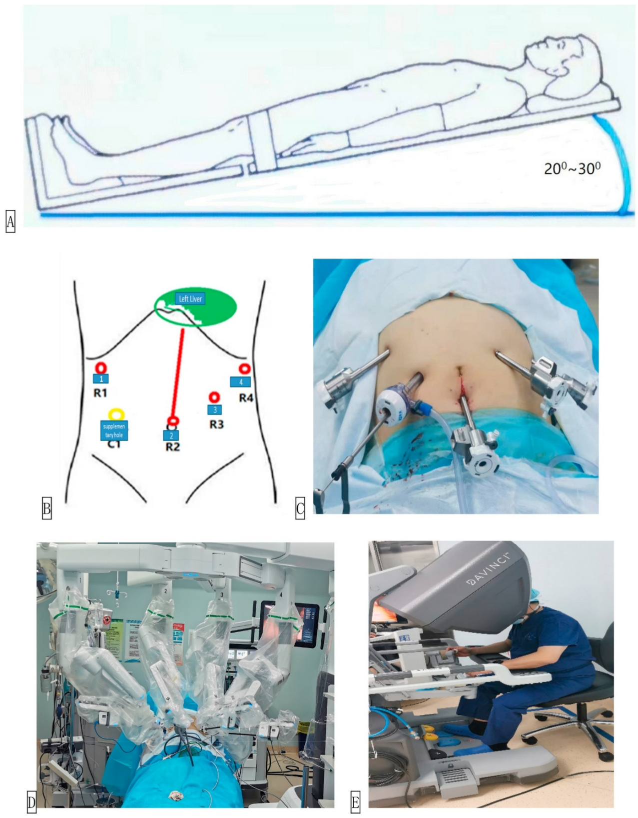


Figure 6. The operation layout of robot assisted hepatectomy. (**A**) Position of the patient. (**B**) Position of the operating hole. (**C**) Photo of the operating hole. (**D**) Da Vinci Xi™ robot (Intuitive Surgical, Sunnyvale, CA, USA) and assistant during operation. (**E**) The surgeon controls the Da Vinci Xi™ robot on the surgeon's console. Reproduced from [Sun et al., Intelligent Surgery, 2022 [257]] under the terms of the Creative Commons Attribution—NonCommercial—NoDerivatives 4.0 International License (https://creativecommons.org/licenses/by-nc-nd/4.0/).

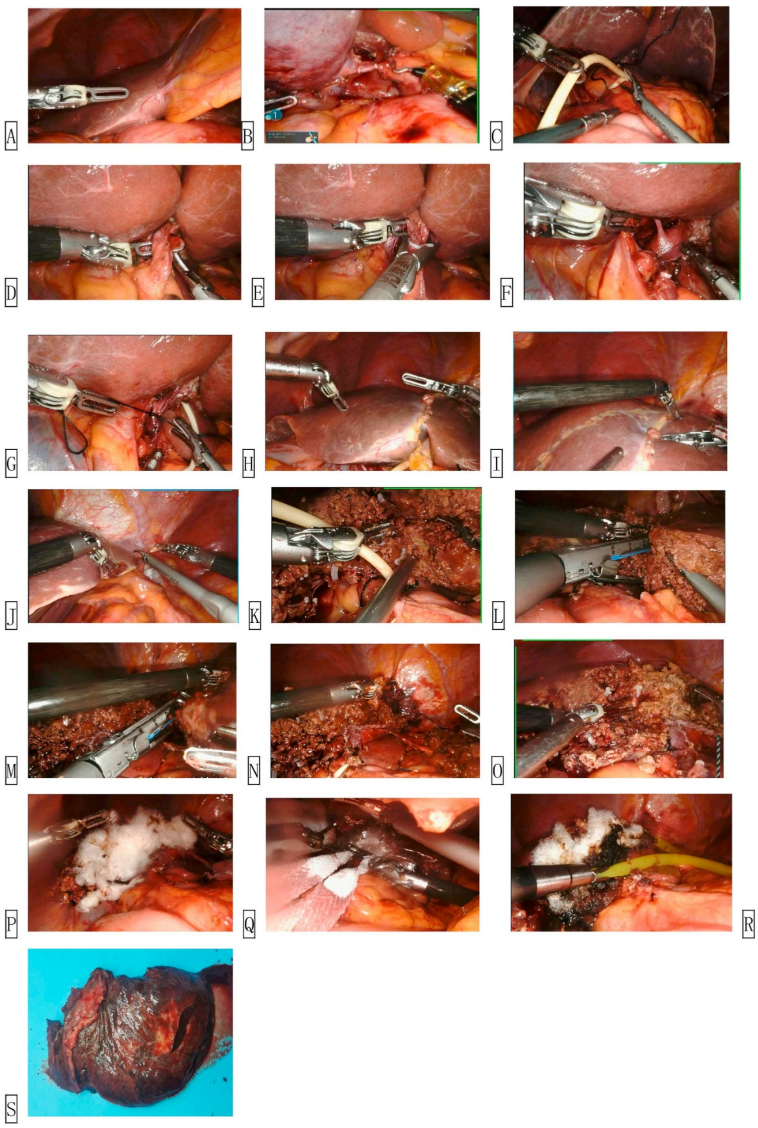


Figure 7. Operation Steps of Robot Assisted Hepatectomy. (**A**) Explore the abdominal cavity. (**B**) Cholecystectomy. (**C**) Place hepatic port blocking tape. (**D**) Isolate the left hepatic artery. (**E**) Ligate the left hepatic artery. (**F**) Isolate the left portal vein. (**G**) Ligate the left portal vein. (**H**) View the ischemic line. (**I**) Line the ischemia line. (**J**) Detach the left deltoid ligament. (**K**) Severed liver. (**L**) Detach the left liver pedicle. (**M**,**N**) Cut off the left hepatic vein. (**O**) Hepatic hemostasis. (**P**) Place hemostatic yarn. (**Q**) Remove the specimen. (**R**) Place drainage tube. (**S**) Sample of left liver. Reproduced from [Sun et al., Intelligent Surgery, 2022 [257]] under the terms of the Creative Commons Attribution—NonCommercial—NoDerivatives 4.0 International License (https://creativecommons.org/licenses/by-nc-nd/4.0/).

Intraoperative ultrasound also plays a crucial role in robotic liver surgery, enabling accurate demarcation of tumor margins and helping guide safe parenchymal transection at an appropriate distance from the lesion.

3.5.2. Advantages and Limitations

Robotic liver resection (RLR) is associated with reduced blood loss, lower conversion rates, and shorter hospital stays compared to open or laparoscopic approaches in major hepatectomies [79,80,86]. Its advantages are especially pronounced in complex resections or in patients with cirrhosis, where reduced bleeding and improved access may reduce postoperative morbidity [87]. Studies also report comparable oncologic outcomes for hepatocellular carcinoma and colorectal liver metastasis between robotic and laparoscopic techniques [88,89]. However, RLR involves significantly longer operative times, and its clinical efficacy remains debated in the literature, with some studies reporting outcomes comparable to conventional approaches without demonstrating clear superiority [90–92]. Additionally, the absence of tactile sensation and high dependency on the bedside assistant for tasks like suctioning or CUSA operation can limit intraoperative autonomy [77,87,93].

3.5.3. Cost-Effectiveness

Robotic liver resection incurs higher direct costs due to robotic instruments, maintenance fees, and increased operating room time. Nonetheless, economic analyses indicate that RLR may be cost-effective in selected high-complexity cases by reducing conversion and complication rates [94,95]. In patients requiring resections of posterosuperior segments or bile duct reconstructions, robotic surgery may offer cost-offsetting benefits by minimizing ICU duration and readmissions. In routine minor resections, however, laparoscopic techniques remain more cost-efficient [89,96].

3.6. Biliary Surgery

Robotic biliary surgery includes both routine benign procedures and highly complex oncologic resections, such as hilar cholangiocarcinoma. Because the included reviews focus on different procedural subsets, the depth and scope of analysis vary accordingly across studies.

3.6.1. Technical Considerations

Surgical robots feature wristed instruments with increased flexibility and enhanced freedom of movement (Figure 8), offering technical advantages in complex cases and patients with altered foregut anatomy [110–112]. In demanding procedures, such as resections for hilar cholangiocarcinoma, robotic systems facilitate meticulous dissection of critical structures including the hepatic artery, portal vein, and biliary confluence within a confined space [113,114]. Lymphadenectomy around the hepatoduodenal ligament is also enhanced by the tremor filtration and stable camera platform of robotic system, supporting precise nodal dissection without vascular injury [110,115]. Robotic platforms improve intracorporeal suturing during hepaticojejunostomy, enabling secure bilioenteric anastomosis with reduced tension and better visualization [115–117]. This precision is particularly beneficial in patients with inflammatory changes, advanced liver disease, or elevated BMI [118,258].

3.6.2. Advantages and Limitations

Robotic biliary surgery demonstrates comparable short-term outcomes to laparoscopic surgery in benign disease, with similar complication rates, blood loss, and hospital stay [111,119,120]. With ongoing technological advancements and growing surgical expertise, its application has expanded to more complex procedures, including resections for hilar cholangiocarcinoma [116,121–123]. However, operative time is generally longer for robotic procedures, particularly in the learning phase [119,120]. Long-term oncologic outcomes, including survival and recurrence rates, are comparable between robotic and laparoscopic approaches for gallbladder cancer and cholangiocarcinoma [115,116]. Limitations of robotic biliary surgery include the lack of haptic feedback, steep learning curve for complex reconstructions, and restricted access in emergency settings or low-resource environments [123].

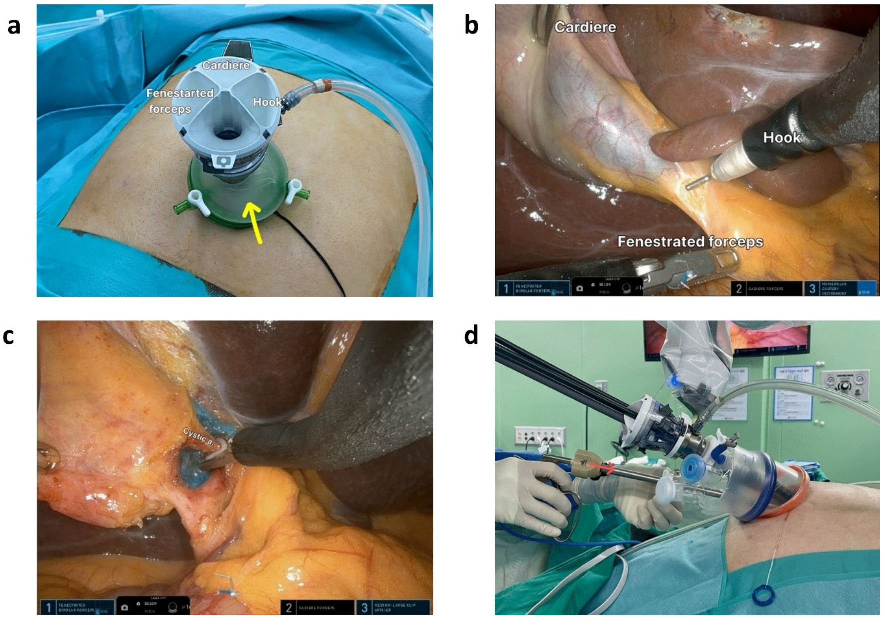


Figure 8. Single-incision robotic cholecystectomy using the da Vinci Single-Port (SP) robotic surgical system. (**a**) The SP system has three robotic arms that can be controlled by the operator. (**b**) The middle arm, in this case, the Cardiere forceps arm, is used for gallbladder traction. (**c**) The multidirectional Endo-Wrist allows approaching the surgical field with the appropriate angle. (**d**) In acute cholecystitis, the cystic duct may become dilated, making it difficult to ligate using a typical single-size medium-large (green) robotic hemolock. In the SP system, the assistant can insert a larger (purple size; red arrow) hemolock through the umbilical port to clip the cystic duct. Reproduced from [Choi et al., Sci Rep, 2023 [258]] under the terms of the Creative Commons Attribution 4.0 International License (https://creativecommons.org/licenses/by/4.0/).

3.6.3. Cost-Effectiveness

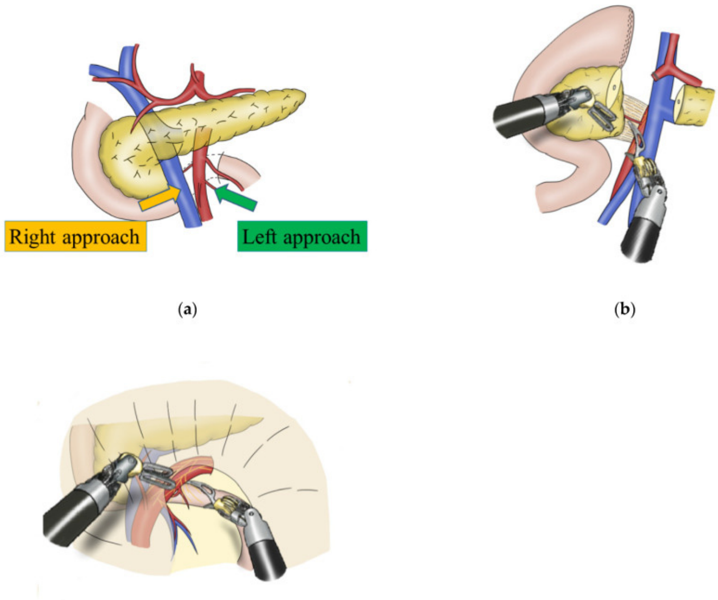
Robotic biliary surgery incurs higher direct costs than laparoscopic surgery, largely due to robotic system acquisition, maintenance, and instrument expenses [124]. Increased operative time and disposable costs further contribute to the financial burden [119–121]. While shorter hospital stays and reduced conversion rates may partially offset expenses in complex cases, routine robotic cholecystectomy has not demonstrated cost-effectiveness over laparoscopy in benign disease [120]. Robotic surgery may provide greater economic value in high-risk or technically demanding cases, such as hilar cholangiocarcinoma, where improved surgical precision may reduce postoperative complications and long-term morbidity [123].

3.7. Pancreatic Surgery

Robotic pancreatic surgery encompasses technically distinct procedures, including distal pancreatectomy and pancreaticoduodenectomy, which differ markedly in complexity. The included reviews emphasize these subprocedures to varying degrees, contributing to heterogeneity in the range and depth of reported outcomes.

3.7.1. Technical Considerations

Pancreatic surgery poses unique technical challenges due to the retroperitoneal location, proximity to major vascular structures, and the complexity of anastomotic reconstruction. In robotic distal pancreatectomy (DP), the wristed instruments facilitate precise dissection along the splenic artery and enable delicate mobilization of the pancreas, especially in spleen-preserving approaches [140]. However, parenchymal transection remains reliant on laparoscopic energy devices or robotic staplers, as robotic-compatible CUSA systems are not widely available [141]. In robotic pancreaticoduodenectomy (PD), stable 3D visualization supports accurate vascular control during dissection of the superior mesenteric vessels (Figure 9), and enhanced dexterity aids in performing duct-to-mucosa pancreaticojejunostomy with finer suturing [142–144,259]. Lymphadenectomy around the hepatoduodenal ligament and interaortocaval regions is also facilitated by the robot's precision in confined retroperitoneal planes. Nevertheless, the complexity of robotic PD demands significant operative experience and institutional infrastructure, particularly for safe execution of anastomoses and vascular management. Limited haptic feedback may affect depth perception during critical steps, requiring reliance on visual cues and surgeon expertise [145].



(a) (b) (c)

Figure 9. Surgical approaches to the superior mesenteric artery (SMA) in robotic pancreaticoduodenectomy. (**a**) Schematic view of the right and left approaches to the SMA. (**b**) The right approach is considered as the standard protocol for RPD. (**c**) The left approach is used in patients with obesity, intra-abdominal adhesions, or malignant diseases requiring lymph node dissection around the SMA. Reproduced from [Takagi et al., JCM, 2022 [259]] under the terms of the Creative Commons Attribution 4.0 International License (https://creativecommons.org/licenses/by/4.0/).

3.7.2. Advantages and Limitations

In distal pancreatectomy (DP), robotic surgery has demonstrated favorable short-term outcomes compared to the laparoscopic approach, including lower conversion rates, reduced intraoperative blood loss, and higher spleen preservation rates, particularly in challenging dissections near the splenic hilum [140]. In pancreaticoduodenectomy (PD), robotic surgery achieves similar morbidity and mortality rates compared to laparoscopic and open approaches, with improved anastomotic precision and potential reductions in delayed gastric emptying and wound infection [146]. Oncologic outcomes, such as R0 resection rates and lymph node yields, are comparable across techniques [147]. However, limitations of robotic pancreatic surgery include prolonged operative times, especially during the learning curve, and the lack of tactile sensation during vascular dissection. Additionally, robotic PD remains restricted to high-volume centers due to its technical demands and resource intensity [145]. Long-term functional outcomes are not yet well defined in the current literature and warrant further study. Access and surgeon training also represent barriers to wider adoption, particularly in low-resource or non-academic centers.

Despite the technical advantages of robotic assistance, postoperative pancreatic fistula remains a significant risk following both distal pancreatectomy and pancreaticoduodenectomy, underscoring the intrinsic complexity of pancreatic surgery regardless of platform.

3.7.3. Cost-Effectiveness

Robotic pancreatic surgery generally incurs higher overall costs compared to laparoscopic and open approaches. The primary cost drivers include robotic system acquisition, maintenance, and the use of disposable instruments [148]. Longer operative times further contribute to increased operating room costs. However, in the case of robotic DP, procedural costs may decrease with surgical experience. Studies suggest that after a minimum of five cases, operative efficiency improves and costs begin to decline, highlighting the importance of structured training [149]. Furthermore, robotic DP and PD have demonstrated advantages including shorter hospital stays, lower conversion rates, and fewer complications, which may contribute to cost mitigation [148–150]. Nonetheless, these benefits have not consistently translated into overall cost savings across institutions. Thus, while the economic justification for robotic surgery remains weak in routine cases, its application may be more favorable in complex or high-risk patients, where its technical advantages can reduce perioperative morbidity and reoperation risk.

3.8. Colorectal Surgery

Robotic colorectal surgery spans procedures of varying difficulty, from right colectomy to deep pelvic total mesorectal excision and IPAA. The included reviews focus on different colorectal subsites, which explains the variability in the level of detail across outcome measures.

3.8.1. Technical Considerations

Robotic colorectal surgery provides distinct technical advantages in procedures involving complex pelvic dissection and challenging anastomoses. In total mesorectal excision (TME) for rectal cancer, the robotic system enhances precision during sharp dissection within the narrow pelvis, facilitating preservation of the hypogastric nerves and pelvic autonomic plexus [178,179]. Pelvic lateral lymph node dissection, which is technically challenging laparoscopically, may also be facilitated by robotic precision in advanced rectal cancer cases [180]. Robotic articulation also enables stable and accurate dissection along the mesorectal plane, reducing the risk of circumferential resection margin involvement [181]. In ileal pouch-anal anastomosis (IPAA), the platform improves suturing in deep pelvic spaces, contributing to secure anastomosis and sphincter preservation [182]. Robotic right colectomy benefits from intracorporeal anastomosis, allowing improved vascular control and tension-free anastomotic construction [183]. Although CUSA is rarely used in colorectal surgery, energy devices such as vessel sealers and robotic staplers play a critical role in mesenteric dissection and division. However, robotic dissection in obese patients or those with bulky tumors remains technically demanding despite improved access angles [184–186]. Splenic flexure mobilization is another challenging step in rectal surgery, but many technical barriers have been mitigated with surgical robot evolution (Figure 10). For instance, the da Vinci Xi system offers a clear advantage over its predecessor, the da Vinci Si, by enabling multi-quadrant surgery without the need for redocking. This allows for a more efficient single-docking approach, reducing operative time and improving access for procedures such as rectosigmoid resection and splenic flexure takedown [260]. Thus, colorectal surgery stands to benefit further from innovations that enhance precision, efficiency, and operative flexibility across the abdominal quadrants.

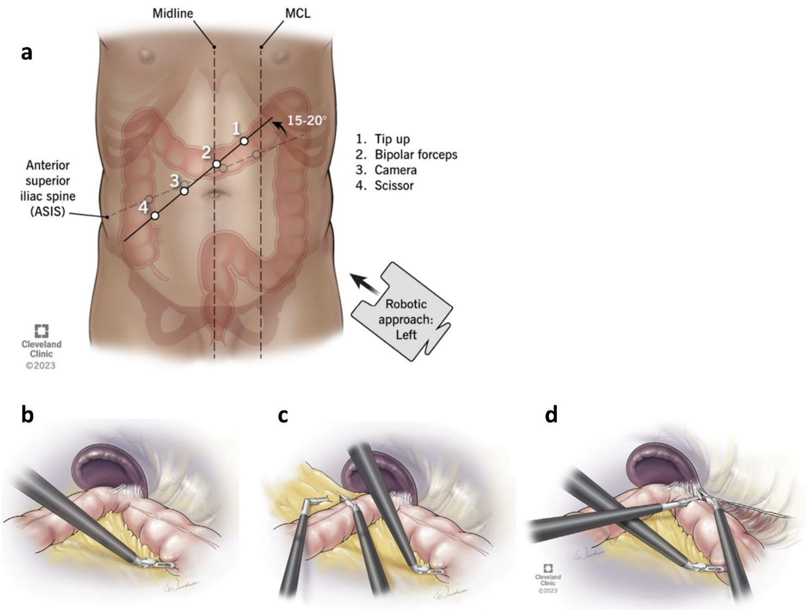


Figure 10. Splenic flexure mobilization in rectal surgery, using the da Vinci Xi robotic system in a cross-armed single-docking approach. First, a tip-up fenestrated grasper inserted through the port number one retracts the descending colon. Then, the arms are crossed either from the medial or lateral aspect of arm one to take down the flexure. (**a**) The standard port placement line was moved 15–20° counterclockwise to facilitate mobilization. (**b**) Traction of descending colon. (**c**) Crossover from the medial aspect of arm one. (**d**) Crossover from the lateral aspect of arm one. Reproduced from [Erozkan et al., MIS, 2023 [260]] under the terms of the Creative Commons Attribution 4.0 International License (https://creativecommons.org/licenses/by/4.0/).

3.8.2. Advantages and Limitations

Robotic colorectal surgery demonstrates improved short-term outcomes compared to laparoscopy in terms of overall complication rates, blood loss, and hospital stay [187,188]. Especially, robotic rectal resection is associated with significantly lower conversion rates to open surgery and improved quality of TME, particularly in male patients with a narrow pelvis or obese patients [189]. In selected cases, robotic surgery enables higher lymph node harvest and improved preservation of urinary and sexual function, attributed to superior nerve-sparing dissection [190]. Long-term oncologic outcomes, including disease-free survival and local recurrence rates, are generally comparable between robotic, laparoscopic, and open approaches [191,192]. Limitations of robotic colorectal surgery include prolonged operative time, particularly during the learning phase, lack of tactile feedback, and high dependence on institutional resources and surgeon expertise [193]. In addition, robotic appendectomy and routine colectomy for benign disease have not demonstrated clear superiority over laparoscopic techniques in uncomplicated cases [194].

3.8.3. Cost-Effectiveness

Robotic colorectal surgery is consistently associated with higher direct costs than laparoscopic approaches due to equipment acquisition, maintenance fees, and use of proprietary instruments [195]. Increased operative time further adds to the total surgical cost. Although the cost-effectiveness of robotic colectomy for benign disease remains limited, reduced conversion rates, shorter hospital stays, and improved functional outcomes may offset expenses in complex pelvic procedures [196]. Current evidence suggests that robotic surgery may provide greater economic value in high-risk or technically demanding cases, such as low rectal cancer or IPAA, where its technical advantages can lead to improved perioperative outcomes and reduced long-term morbidity [182,197].

4. Discussion

Robotic surgery has advanced gastrointestinal (GI) surgery by offering enhanced visualization, dexterity, and instrument control in anatomically complex spaces. However, its clinical value is not uniform across surgical domains and depends heavily on procedural complexity, institutional volume, and resource availability. A cross-domain comparative summary of robotic GI surgery is provided in Table 2.

Table 2. Cross-domain comparative summary of robotic gastrointestinal surgery.

Domain	Optimal Indications	Established Clinical Benefits	Cost-Effectiveness	Evidence-Based Conclusion
Esophageal	McKeown or Ivor Lewis esophagectomy; Heller myotomy	Lower pulmonary and nerve injury rates; Improved lymph node yield	Potentially justified in complex cases	Selectively recommended for complex cases.
Gastric	D2 lymphadenectomy; High-risk or obese patients	Lower conversion and complication rates; Improved lymphadenectomy and anastomotic precision	Moderate only in high-risk cases	Selectively recommended for high-risk cases; cost restricts broad adoption.
Liver	Posterior segmentectomy; Bile duct reconstruction; Cirrhotic liver	Lower conversion rates; Shorter hospital stays; Enhanced access in complex resections	Favorable only in complex resections	Selectively recommended for complex cases; cost and debated clinical superiority restrict routine use.
Biliary	Hilar cholangiocarcinoma; Hepaticojejunostomy; High BMI or inflammation	Enhanced dissection and suturing in confined spaces; Improved lymphadenectomy and anastomotic precision; Comparable in benign disease	Potentially justified in complex or high-risk oncologic cases	Selectively recommended for high-risk cases; further evidence needed to justify broader adoption.
Pancreatic	PD; Spleen-preserving DP; High-risk or obese patients	Lower conversion rates; Improved anastomotic precision in PD; Comparable oncologic outcomes	Favorable in complex cases and high-volume centers; Improves with training and experience	Strongest evidence of clinical value in high-risk cases or advanced centers; not yet scalable for routine implementation.
Colorectal	TME; IPAA; Rectal cancer in male or obese patients	Lower complication and conversion rates; Shorter hospital stays; Improved nerve preservation	Reasonable in complex cases; Justified by reduced morbidity and enhanced functional outcomes	Substantial advantages in high-risk pelvic cases, particularly rectal cancer; cost restricts routine use for benign conditions.

BMI: body mass index; PD: pancreaticoduodenectomy; DP: distal pancreatectomy; TME: total mesorectal excision; IPAA: ileal pouch-anal anastomosis.

Among the six domains, robotic assistance appears to confer the most consistent clinical advantage in pancreatic and colorectal surgery. Clinically, robotic assistance enhances dissection in dense anatomical planes, reduces conversion rates, and shortens hospital stays. These benefits are particularly evident in demanding procedures such as total mesorectal excision and pancreaticoduodenectomy, where the precision of robotic systems improves safety and technical outcomes. Economically, both procedures may achieve cost-efficiency in high-volume centers by reducing complications and facilitating faster recovery.

Despite these advantages, certain procedures with strong theoretical benefits remain underutilized in robotic practice. For example, robotic liver surgery offers enhanced access and fine control, particularly in posterior segment resections, yet its adoption remains limited due to technical demands, steep learning curves, and a lack of high-quality data. This mismatch between potential benefit and real-world adoption warrants attention. Structured training programs and multi-institutional collaborations could help standardize technique and generate stronger evidence to guide implementation.

Moving forward, the expansion of robotic surgery should be driven by clinical value, not technological novelty. While robotic systems provide significant advantages in certain GI procedures, their optimal use depends on thoughtful procedural selection, institutional expertise, and ongoing evidence generation. Integration of robotic platforms must be guided by procedure-specific outcomes, long-term oncologic safety, and cost-effectiveness. Future research should prioritize comparative studies across diverse healthcare settings, especially in lower-volume centers and regions with constrained surgical access, to evaluate scalability and equity in robotic care delivery. Addressing the gap between potential and practice will be essential in shaping the next phase of robotic gastrointestinal surgery.

This umbrella review has several inherent limitations. First, the analysis depends entirely on previously published systematic reviews and meta-analyses, and therefore inherits their methodological variability, including differences in search scope, patient selection, and outcome definitions. Second, comparator heterogeneity—some reviews comparing robotic surgery to laparoscopic approaches, others to open surgery—limits the ability to standardize effect estimates across domains. Third, variations in robotic platforms across studies (e.g., da Vinci, SP, Versius, Senhance) introduce additional heterogeneity, as most evidence remains dominated by da Vinci systems. Finally, because umbrella reviews do not reanalyze primary data, the depth of procedure-specific comparisons is constrained by the granularity of the included reviews. These limitations should be considered when interpreting the findings.

5. Conclusions

This umbrella review analyzed 250 studies across six GI surgical domains to assess the comparative value of robotic surgery. Robotic platforms enhance dexterity, visualization, and ergonomics, with the most notable benefits being seen in complex pancreatic and colorectal procedures. These cases show lower conversion rates and fewer complications, with outcomes that are comparable to conventional approaches. While high costs remain a challenge, the findings of this review may serve as a valuable resource for clinicians, surgical trainees, and healthcare decision-makers evaluating the appropriate integration of robotic platforms into gastrointestinal surgical practice. Continued technological refinement, coupled with rigorous clinical research, will be essential to defining the optimal role of robotic surgery.

Supplementary Materials: The following supporting information can be downloaded at https://www.mdpi.com/article/10.3390/jcm14238555/s1: Table S1: Full Search Strategy; Table S2: PRISMA 2020 Checklist; Table S3: PRISMA Abstract Checklist; Table S4: AMSTAR 2 evaluation of the key studies in each surgical domain; Table S5: CCA calculation using a citation matrix of eligible reviews in each surgical domain; Table S6: General characteristics of the 250 articles included in this umbrella review.

Author Contributions: Conceptualization, S.H.R. and J.L.; methodology, S.H.R. and J.L.; formal analysis, S.H.R. and J.L.; investigation, S.H.R. and J.L.; data curation, S.H.R. and J.L.; writing—original draft preparation, S.H.R. and J.L.; writing—review and editing, S.H.R. and J.L.; visualization, S.H.R. and J.L.; supervision, S.H.R. and J.S.L.; project administration, S.H.R. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable (this study is an umbrella review and does not involve humans or animals).

Informed Consent Statement: Not applicable (this study did not involve humans).

Data Availability Statement: This study is an umbrella review and does not involve the collection or generation of original data. All data analyzed were derived from previously published studies, which are publicly available through the original publications. The data supporting the findings of this study are available from the corresponding author upon reasonable request.

Conflicts of Interest: The authors declare no conflicts of interest.

Abbreviations

The following abbreviations are used in this manuscript:

AMSTAR2	A Measurement Tool to Assess Systematic Reviews 2
BMI	Body Mass Index
CCA	Corrected Covered Area
CUSA	Cavitron Ultrasonic Surgical Aspirator
DP	Distal Pancreatectomy
GI	Gastrointestinal
IPAA	Ileal Pouch-Anal Anastomosis
LG	Laparoscopic Gastrectomy
MIS	Minimally Invasive Surgery
PD	Pancreaticoduodenectomy
RAMIE	Robotic-Assisted Minimally Invasive Esophagectomy
RAS	Robotic-Assisted Surgery
RG	Robotic Gastrectomy
RLR	Robotic Liver Resection
SP	Single-Port
TME	Total Mesorectal Excision

References

1. Minamimura, K.; Hara, K.; Matsumoto, S.; Yasuda, T.; Arai, H.; Kakinuma, D.; Ohshiro, Y.; Kawano, Y.; Watanabe, M.; Suzuki, H.; et al. Current Status of Robotic Gastrointestinal Surgery. *J. Nippon Med. Sch.* **2023**, *90*, 308–315. [CrossRef]
2. Vining, C.C.; Skowron, K.B.; Hogg, M.E. Robotic Gastrointestinal Surgery: Learning Curve, Educational Programs and Outcomes. *Updates Surg.* **2021**, *73*, 799–814. [CrossRef]
3. Ngu, J.; Tsang, C.; Koh, D. The Da Vinci Xi: A Review of Its Capabilities, Versatility, and Potential Role in Robotic Colorectal Surgery. *Robot. Surg.* **2017**, *4*, 77–85. [CrossRef]
4. Celotto, F.; Ramacciotti, N.; Mangano, A.; Danieli, G.; Pinto, F.; Lopez, P.; Ducas, A.; Cassiani, J.; Morelli, L.; Spolverato, G.; et al. Da Vinci Single-Port Robotic System Current Application and Future Perspective in General Surgery: A Scoping Review. *Surg. Endosc.* **2024**, *38*, 4814–4830. [CrossRef]
5. Aiolfi, A.; Damiani, R.; Manara, M.; Cammarata, F.; Bonitta, G.; Biondi, A.; Bona, D.; Bonavina, L. Robotic versus Laparoscopic Heller Myotomy for Esophageal Achalasia: An Updated Systematic Review and Meta-Analysis. *Langenbeck's Arch. Surg.* **2025**, *410*, 75. [CrossRef]
6. Khachfe, H.H.; Habib, J.R.; Harthi, S.A.; Suhool, A.; Hallal, A.H.; Jamali, F.R. Robotic Pancreas Surgery: An Overview of History and Update on Technique, Outcomes, and Financials. *J. Robot. Surg.* **2022**, *16*, 483–494. [CrossRef]
7. Patti, J.C.; Ore, A.S.; Barrows, C.; Velanovich, V.; Moser, A.J. Value-Based Assessment of Robotic Pancreas and Liver Surgery. *Hepatobiliary Surg. Nutr.* **2017**, *6*, 246–257. [CrossRef]
8. Pieper, D.; Antoine, S.-L.; Mathes, T.; Neugebauer, E.A.M.; Eikermann, M. Systematic Review Finds Overlapping Reviews Were Not Mentioned in Every Other Overview. *J. Clin. Epidemiol.* **2014**, *67*, 368–375. [CrossRef] [PubMed]
9. Kanamori, J.; Watanabe, M.; Maruyama, S.; Kanie, Y.; Fujiwara, D.; Sakamoto, K.; Okamura, A.; Imamura, Y. Current Status of Robot-Assisted Minimally Invasive Esophagectomy: What Is the Real Benefit? *Surg. Today* **2022**, *52*, 1246–1253. [CrossRef] [PubMed]

10. Angeramo, C.A.; Bras Harriott, C.; Casas, M.A.; Schlottmann, F. Minimally Invasive Ivor Lewis Esophagectomy: Robot-Assisted versus Laparoscopic–Thoracoscopic Technique. Systematic Review and Meta-Analysis. *Surgery* **2021**, *170*, 1692–1701. [CrossRef] [PubMed]
11. Jin, D.; Yao, L.; Yu, J.; Liu, R.; Guo, T.; Yang, K.; Gou, Y. Robotic-assisted Minimally Invasive Esophagectomy versus the Conventional Minimally Invasive One: A Meta-analysis and Systematic Review. *Int. J. Med. Robot.* **2019**, *15*, e1988. [CrossRef]
12. Li, X.-K.; Xu, Y.; Zhou, H.; Cong, Z.-Z.; Wu, W.-J.; Qiang, Y.; Shen, Y. Does Robot-Assisted Minimally Invasive Oesophagectomy Have Superiority over Thoraco-Laparoscopic Minimally Invasive Oesophagectomy in Lymph Node Dissection? *Dis. Esophagus* **2021**, *34*, doaa050. [CrossRef] [PubMed]
13. Patel, N.M.; Patel, P.H.; Yeung, K.T.D.; Monk, D.; Mohammadi, B.; Mughal, M.; Bhogal, R.H.; Allum, W.; Abbassi-Ghadi, N.; Kumar, S. Is Robotic Surgery the Future for Resectable Esophageal Cancer?: A Systematic Literature Review of Oncological and Clinical Outcomes. *Ann. Surg. Oncol.* **2024**, *31*, 4281–4297. [CrossRef]
14. Perry, R.; Barbosa, J.P.; Perry, I.; Barbosa, J. Short-Term Outcomes of Robot-Assisted versus Conventional Minimally Invasive Esophagectomy for Esophageal Cancer: A Systematic Review and Meta-Analysis of 18,187 Patients. *J. Robot. Surg.* **2024**, *18*, 125. [CrossRef]
15. Damani, T.; Ballantyne, G. Robotic Foregut Surgery. *Surg. Clin. N. Am.* **2020**, *100*, 249–264. [CrossRef]
16. Vashist, Y.; Goyal, A.; Shetty, P.; Girnyi, S.; Cwalinski, T.; Skokowski, J.; Malerba, S.; Prete, F.P.; Mocarski, P.; Kania, M.K.; et al. Evaluating Postoperative Morbidity and Outcomes of Robotic-Assisted Esophagectomy in Esophageal Cancer Treatment—A Comprehensive Review on Behalf of TROGSS (The Robotic Global Surgical Society) and EFISDS (European Federation International Society for Digestive Surgery) Joint Working Group. *Curr. Oncol.* **2025**, *32*, 72. [PubMed]
17. McKinley, S.K.; Dirks, R.C.; Walsh, D.; Hollands, C.; Arthur, L.E.; Rodriguez, N.; Jhang, J.; Abou-Setta, A.; Pryor, A.; Stefanidis, D.; et al. Surgical Treatment of GERD: Systematic Review and Meta-Analysis. *Surg. Endosc.* **2021**, *35*, 4095–4123. [CrossRef]
18. Ramjit, S.E.; Ashley, E.; Donlon, N.E.; Weiss, A.; Doyle, F.; Heskin, L. Safety, Efficacy, and Cost-Effectiveness of Minimally Invasive Esophagectomies versus Open Esophagectomies: An Umbrella Review. *Dis. Esophagus* **2022**, *35*, doaa025. [CrossRef] [PubMed]
19. Tartaglia, N.; Pavone, G.; Di Lascia, A.; Vovola, F.; Maddalena, F.; Fersini, A.; Pacilli, M.; Ambrosi, A. Robotic Voluminous Paraesophageal Hernia Repair: A Case Report and Review of the Literature. *J. Med. Case Rep.* **2020**, *14*, 25. [CrossRef]
20. Karikis, I.; Pachos, N.; Mela, E.; Saliaris, K.; Kitsou, E.; Linardoutsos, D.; Triantafyllou, S.; Theodorou, D. Comparative Analysis of Robotic and Laparoscopic Techniques in Hiatal Hernia and Crural Repair: A Review of Current Evidence and Outcomes. *Hernia* **2024**, *28*, 1559–1569. [CrossRef]
21. Fiume, I.; Molena, D. Robotic Esophagomyotomy for Achalasia: Technical Note and Review of the Literature. *Minerva Surg.* **2022**, *77*, 157–170. [CrossRef]
22. Watanabe, M.; Kuriyama, K.; Terayama, M.; Okamura, A.; Kanamori, J.; Imamura, Y. Robotic-Assisted Esophagectomy: Current Situation and Future Perspectives. *Ann. Thorac. Cardiovasc. Surg.* **2023**, *29*, 168–176. [CrossRef]
23. Rebecchi, F.; Ugliono, E.; Allaix, M.E.; Morino, M. Why Pay More for Robot in Esophageal Cancer Surgery? *Updates Surg.* **2023**, *75*, 367–372. [CrossRef]
24. Witek, T.D.; Melvin, T.J.; Luketich, J.D.; Sarkaria, I.S. Open, Minimally Invasive, and Robotic Approaches for Esophagectomy. *Thorac. Surg. Clin.* **2020**, *30*, 269–277. [CrossRef]
25. Zhou, J.; Xu, J.; Chen, L.; Hu, J.; Shu, Y. McKeown Esophagectomy: Robot-Assisted versus Conventional Minimally Invasive Technique—Systematic Review and Meta-Analysis. *Dis. Esophagus* **2022**, *35*, doac011. [CrossRef]
26. Weindelmayer, J.; De Pasqual, C.A.; Turolo, C.; Gervasi, M.C.; Sacco, M.; Bencivenga, M.; Giacopuzzi, S. Robotic versus Open Ivor–Lewis Esophagectomy: A More Accurate Lymph Node Dissection without Burdening the Leak Rate. *J. Surg. Oncol.* **2023**, *127*, 1109–1115. [CrossRef] [PubMed]
27. Siaw-Acheampong, K.; Kamarajah, S.K.; Gujjuri, R.; Bundred, J.R.; Singh, P.; Griffiths, E.A. Minimally Invasive Techniques for Transthoracic Oesophagectomy for Oesophageal Cancer: Systematic Review and Network Meta-Analysis. *BJS Open* **2020**, *4*, 787–803. [CrossRef]
28. Milone, M.; Manigrasso, M.; Vertaldi, S.; Velotti, N.; Aprea, G.; Maione, F.; Gennarelli, N.; De Simone, G.; De Conno, B.; Pesce, M.; et al. Robotic versus Laparoscopic Approach to Treat Symptomatic Achalasia: Systematic Review with Meta-Analysis. *Dis. Esophagus* **2019**, *32*, 1–8. [CrossRef]
29. Xie, J.; Vatsan, M.S.; Gangemi, A. Laparoscopic versus Robotic-assisted Heller Myotomy for the Treatment of Achalasia: A Systematic Review with Meta-analysis. *Int. J. Med. Robot.* **2021**, *17*, e2253. [CrossRef]
30. Mederos, M.A.; De Virgilio, M.J.; Shenoy, R.; Ye, L.; Toste, P.A.; Mak, S.S.; Booth, M.S.; Begashaw, M.M.; Wilson, M.; Gunnar, W.; et al. Comparison of Clinical Outcomes of Robot-Assisted, Video-Assisted, and Open Esophagectomy for Esophageal Cancer: A Systematic Review and Meta-Analysis. *JAMA Netw. Open* **2021**, *4*, e2129228. [CrossRef]
31. Gonçalves-Costa, D.; Barbosa, J.P.; Quesado, R.; Lopes, V.; Barbosa, J. Robotic Surgery versus Laparoscopic Surgery for Anti-Reflux and Hiatal Hernia Surgery: A Short-Term Outcomes and Cost Systematic Literature Review and Meta-analysis. *Langenbeck's Arch. Surg.* **2024**, *409*, 175. [CrossRef]

32. Huang, Y.; Zhao, Y.L.; Song, J.D. Early Outcomes with Robot-Assisted vs. Minimally Invasive Esophagectomy for Esophageal Cancer: A Systematic Review and Meta-Analysis of Matched Studies. *Eur. Rev. Med. Pharmacol. Sci.* **2021**, *25*, 7887–7897.
33. Marano, L.; Fusario, D.; Savelli, V.; Marrelli, D.; Roviello, F. Robotic versus Laparoscopic Gastrectomy for Gastric Cancer: An Umbrella Review of Systematic Reviews and Meta-Analyses. *Updates Surg.* **2021**, *73*, 1673–1689. [CrossRef]
34. Guerrini, G.P.; Esposito, G.; Magistri, P.; Serra, V.; Guidetti, C.; Olivieri, T.; Catellani, B.; Assirati, G.; Ballarin, R.; Di Sandro, S.; et al. Robotic versus Laparoscopic Gastrectomy for Gastric Cancer: The Largest Meta-Analysis. *Int. J. Surg.* **2020**, *82*, 210–228. [CrossRef]
35. Morrell, A.L.G.; Morrell-Junior, A.C.; Morrell, A.G.; Mendes, J.M.F.; Morrell, A.C. Robotic Roux-En-Y Gastric Bypass: Surgical Technique and Short-Term Experience from 329 Cases. *Rev. Do Colégio Bras. De Cir.* **2021**, *48*, e20212982. [CrossRef]
36. Kotidis, E.; Pramateftakis, M.G.; Tatsis, D. Technical Aspects, Short- and Long-Term Outcomes of Laparoscopic and Robotic D2-Lymphadectomy in Gastric Cancer. *J. BUON* **2019**, *24*, 889–896.
37. Wang, L.; Yao, L.; Yan, P.; Xie, D.; Han, C.; Liu, R.; Yang, K.; Guo, T.; Tian, L. Robotic Versus Laparoscopic Roux-En-Y Gastric Bypass for Morbid Obesity: A Systematic Review and Meta-Analysis. *Obes. Surg.* **2018**, *28*, 3691–3700. [CrossRef]
38. Du, X.; Shen, L.; Xu, S.; Xu, W.; Yang, J.; Liu, Y.; Li, K.; Fan, R.; Yan, L. Primary Robotic Versus Conventional Laparoscopic Roux-En-Y Gastric Bypass in Morbidly Obese Patients: A Systematic Review and Meta-Analysis. *Surg. Laparosc. Endosc. Percutaneous Tech.* **2024**, *34*, 383–393. [CrossRef]
39. Yang, L.-W.; Bai, X.-Y.; Jing, G.-M. Systematic Review and Meta-Analysis of Short-Term Outcomes: Robot-Assisted versus Laparoscopic Surgery for Gastric Cancer Patients with Visceral Obesity. *J. Robot. Surg.* **2024**, *18*, 238. [CrossRef]
40. Marano, L.; Cwalinski, T.; Girnyi, S.; Skokowski, J.; Goyal, A.; Malerba, S.; Prete, F.P.; Mocarski, P.; Kania, M.K.; Świerblewski, M.; et al. Evaluating the Role of Robotic Surgery Gastric Cancer Treatment: A Comprehensive Review by the Robotic Global Surgical Society (TROGSS) and European Federation International Society for Digestive Surgery (EFISDS) Joint Working Group. *Curr. Oncol.* **2025**, *32*, 83. [CrossRef]
41. Shibasaki, S.; Suda, K.; Obama, K.; Yoshida, M.; Uyama, I. Should Robotic Gastrectomy Become a Standard Surgical Treatment Option for Gastric Cancer? *Surg. Today* **2020**, *50*, 955–965. [CrossRef]
42. Gong, S.; Li, X.; Tian, H.; Song, S.; Lu, T.; Jing, W.; Huang, X.; Xu, Y.; Wang, X.; Zhao, K.; et al. Clinical Efficacy and Safety of Robotic Distal Gastrectomy for Gastric Cancer: A Systematic Review and Meta-Analysis. *Surg. Endosc.* **2022**, *36*, 2734–2748. [CrossRef]
43. Leang, Y.J.; Mayavel, N.; Yang, W.T.W.; Kong, J.C.H.; Hensman, C.; Burton, P.R.; Brown, W.A. Robotic versus Laparoscopic Gastric Bypass in Bariatric Surgery: A Systematic Review and Meta-Analysis on Perioperative Outcomes. *Surg. Obes. Relat. Dis.* **2024**, *20*, 62–71. [CrossRef]
44. Kossenas, K.; Moutzouri, O.; Georgopoulos, F. Evaluating the Safety of Robotic Total Gastrectomy with D2 Lymphadenectomy for Gastric Cancer against the Conventional Laparoscopic Approach: A Systematic Review and Meta-Analysis. *J. Robot. Surg.* **2025**, *19*, 59. [CrossRef] [PubMed]
45. Marrelli, D.; Carbone, L.; Poto, G.E.; Fusario, D.; Gjoka, M.; Andreucci, E.; Piccioni, S.A.; Calomino, N.; Sandini, M.; Roviello, F. Minimally Invasive Lymphadenectomy for Gastric Cancer: Could the Robotic Approach Provide Any Benefits over Laparoscopy? *World J. Gastrointest. Oncol.* **2025**, *17*, 104015. [CrossRef]
46. Guerra, F.; Giuliani, G.; Formisano, G.; Bianchi, P.P.; Patriti, A.; Coratti, A. Pancreatic Complications After Conventional Laparoscopic Radical Gastrectomy Versus Robotic Radical Gastrectomy: Systematic Review and Meta-Analysis. *J. Laparoendosc. Adv. Surg. Tech. A* **2018**, *28*, 1207–1215. [CrossRef]
47. Ma, J.; Li, X.; Zhao, S.; Zhang, R.; Yang, D. Robotic versus Laparoscopic Gastrectomy for Gastric Cancer: A Systematic Review and Meta-Analysis. *World J. Surg. Oncol.* **2020**, *18*, 306. [CrossRef]
48. Du, R.; Wan, Y.; Shang, Y.; Lu, G. Robotic Versus Laparoscopic Gastrectomy for Gastric Cancer: The Largest Systematic Reviews of 68,755 Patients and Meta-Analysis. *Ann. Surg. Oncol.* **2025**, *32*, 351–373. [CrossRef]
49. Davey, M.G.; Temperley, H.C.; O'Sullivan, N.J.; Marcelino, V.; Ryan, O.K.; Ryan, É.J.; Donlon, N.E.; Johnston, S.M.; Robb, W.B. Minimally Invasive and Open Gastrectomy for Gastric Cancer: A Systematic Review and Network Meta-Analysis of Randomized Clinical Trials. *Ann. Surg. Oncol.* **2023**, *30*, 5544–5557. [CrossRef] [PubMed]
50. Kim, Y.M.; Hyung, W.J. Current Status of Robotic Gastrectomy for Gastric Cancer: Comparison with Laparoscopic Gastrectomy. *Updates Surg.* **2021**, *73*, 853–863. [CrossRef] [PubMed]
51. Shibasaki, S.; Suda, K.; Hisamori, S.; Obama, K.; Terashima, M.; Uyama, I. Robotic Gastrectomy for Gastric Cancer: Systematic Review and Future Directions. *Gastric Cancer* **2023**, *26*, 325–338. [CrossRef] [PubMed]
52. Zizzo, M.; Zanelli, M.; Sanguedolce, F.; Torricelli, F.; Morini, A.; Tumiati, D.; Mereu, F.; Zuliani, A.L.; Palicelli, A.; Ascani, S.; et al. Robotic versus Laparoscopic Gastrectomy for Gastric Cancer: An Updated Systematic Review. *Medicina* **2022**, *58*, 834. [CrossRef] [PubMed]
53. Van Boxel, G.I.; Ruurda, J.P.; Van Hillegersberg, R. Robotic-Assisted Gastrectomy for Gastric Cancer: A European Perspective. *Gastric Cancer* **2019**, *22*, 909–919. [CrossRef]

54. Zhang, Z.; Miao, L.; Ren, Z.; Li, Y. Robotic Bariatric Surgery for the Obesity: A Systematic Review and Meta-Analysis. *Surg. Endosc.* **2021**, *35*, 2440–2456. [CrossRef]
55. Roriz-Silva, R.; Vilallonga, R.; Fort, J.M.; Khoraki, J.; De Gordejuela, A.G.R.; Gonzalez, O.; Caubet, E.; Rodríguez-Luna, M.R.; Armengol, M. Robotic and Laparoscopic Roux-En-Y Gastric Bypass after Learning Curve: 30-Day and 12-Month Outcomes. *J. Robot. Surg.* **2022**, *16*, 1257–1263. [CrossRef]
56. Ong, C.T.; Schwarz, J.L.; Roggin, K.K. Surgical Considerations and Outcomes of Minimally Invasive Approaches for Gastric Cancer Resection. *Cancer* **2022**, *128*, 3910–3918. [CrossRef]
57. Chen, L.; Wang, Q.; Liu, Y.; Wang, Y.; Li, Y.; Dan, J.; Wang, J. A Meta-Analysis of Robotic Gastrectomy versus Open Gastrectomy in Gastric Cancer Treatment. *Asian J. Surg.* **2022**, *45*, 698–706. [CrossRef] [PubMed]
58. Bertoni, M.V.; Marengo, M.; Garofalo, F.; Volontè, F.; La Regina, D.; Gass, M.; Mongelli, F. Robotic-Assisted Versus Laparoscopic Revisional Bariatric Surgery: A Systematic Review and Meta-Analysis on Perioperative Outcomes. *Obes. Surg.* **2021**, *31*, 5022–5033. [CrossRef]
59. Zhao, S.; Fu, Y.; Zhou, J.; Sun, L.; Li, R.; Tian, Z.; Cheng, Y.; Wang, J.; Wang, W.; Wang, D. Comparing the Efficacy of Robotic Versus Laparoscopic Sleeve Gastrectomy: A Systematic Review and Meta-Analysis. *Obes. Surg.* **2024**, *34*, 3493–3505. [CrossRef]
60. Li, Z.; Zhou, W.; Yang, W.; Miao, Y.; Zhang, Y.; Duan, L.; Niu, L.; Chen, J.; Fan, A.; Xie, Q.; et al. Efficacy and Safety of Robotic vs. Laparoscopic Gastrectomy for Patients with Gastric Cancer: Systematic Review and Meta-Analysis. *Int. J. Surg.* **2024**, *110*, 8045–8056. [CrossRef]
61. Aoyama, T.; Maezawa, Y.; Hashimoto, I. Open, Laparoscopy-Assisted, Robotic-Assisted Distal Gastrectomy for Gastric Cancer: Evidence from Randomized Clinical Trials. *Anticancer Res.* **2024**, *44*, 3737–3745. [CrossRef]
62. Triemstra, L.; Den Boer, R.B.; Rovers, M.M.; Hazenberg, C.E.V.B.; Van Hillegersberg, R.; Grutters, J.P.C.; Ruurda, J.P. A Systematic Review on the Effectiveness of Robot-Assisted Minimally Invasive Gastrectomy. *Gastric Cancer* **2024**, *27*, 932–946. [CrossRef]
63. Kossenas, K.; Moutzouri, O.; Georgopoulos, F. Robotic vs Laparoscopic Distal Gastrectomy with Billroth I and II Reconstruction: A Systematic Review and Meta-Analysis. *J. Robot. Surg.* **2024**, *19*, 30. [CrossRef]
64. Aiolfi, A.; Tornese, S.; Bonitta, G.; Rausa, E.; Micheletto, G.; Bona, D. Roux-En-Y Gastric Bypass: Systematic Review and Bayesian Network Meta-Analysis Comparing Open, Laparoscopic, and Robotic Approach. *Surg. Obes. Relat. Dis.* **2019**, *15*, 985–994. [CrossRef] [PubMed]
65. Solaini, L.; Avanzolini, A.; Pacilio, C.A.; Cucchetti, A.; Cavaliere, D.; Ercolani, G. Robotic Surgery for Gastric Cancer in the West: A Systematic Review and Meta-Analyses of Short-and Long-Term Outcomes. *Int. J. Surg.* **2020**, *83*, 170–175. [CrossRef] [PubMed]
66. Qiu, H.; Ai, J.-H.; Shi, J.; Shan, R.-F.; Yu, D.-J. Effectiveness and Safety of Robotic versus Traditional Laparoscopic Gastrectomy for Gastric Cancer: An Updated Systematic Review and Meta-Analysis. *J. Cancer Res. Ther.* **2019**, *15*, 1450. [CrossRef]
67. Hoshino, N.; Murakami, K.; Hida, K.; Hisamori, S.; Tsunoda, S.; Obama, K.; Sakai, Y. Robotic versus Laparoscopic Surgery for Gastric Cancer: An Overview of Systematic Reviews with Quality Assessment of Current Evidence. *Updates Surg.* **2020**, *72*, 573–582. [CrossRef] [PubMed]
68. Wang, Q.; Leng, J.; Li, W.; Chen, J. A Comprehensive Review and Meta-Analysis Comparing Robot-Assisted and 3D Laparoscopic Gastrectomy for Gastric Cancer. *J. Robot. Surg.* **2025**, *19*, 96. [CrossRef]
69. Sun, T.; Wang, Y.; Liu, Y.; Wang, Z. Perioperative Outcomes of Robotic versus Laparoscopic Distal Gastrectomy for Gastric Cancer: A Meta-Analysis of Propensity Score-Matched Studies and Randomized Controlled Trials. *BMC Surg.* **2022**, *22*, 427. [CrossRef]
70. Aiolfi, A.; Lombardo, F.; Matsushima, K.; Sozzi, A.; Cavalli, M.; Panizzo, V.; Bonitta, G.; Bona, D. Systematic Review and Updated Network Meta-Analysis of Randomized Controlled Trials Comparing Open, Laparoscopic-Assisted, and Robotic Distal Gastrectomy for Early and Locally Advanced Gastric Cancer. *Surgery* **2021**, *170*, 942–951. [CrossRef]
71. Li, W.; Wei, S.-J. Perioperative Outcomes of Robot-Assisted versus Laparoscopic Distal Gastrectomy for Gastric Cancer: A Systematic Review and Meta-Analysis of Propensity Score Matching Studies. *J. Robot. Surg.* **2024**, *18*, 333. [CrossRef]
72. Jin, T.; Liu, H.-D.; Yang, K.; Chen, Z.-H.; Zhang, Y.-X.; Hu, J.-K. Effectiveness and Safety of Robotic Gastrectomy versus Laparoscopic Gastrectomy for Gastric Cancer: A Meta-Analysis of 12,401 Gastric Cancer Patients. *Updates Surg.* **2022**, *74*, 267–281. [CrossRef]
73. Bobo, Z.; Xin, W.; Jiang, L.; Quan, W.; Liang, B.; Xiangbing, D.; Ziqiang, W. Robotic Gastrectomy versus Laparoscopic Gastrectomy for Gastric Cancer: Meta-Analysis and Trial Sequential Analysis of Prospective Observational Studies. *Surg. Endosc.* **2019**, *33*, 1033–1048. [CrossRef]
74. Zhang, Z.; Zhang, X.; Liu, Y.; Li, Y.; Zhao, Q.; Fan, L.; Zhang, Z.; Wang, D.; Zhao, X.; Tan, B. Meta-Analysis of the Efficacy of Da Vinci Robotic or Laparoscopic Distal Subtotal Gastrectomy in Patients with Gastric Cancer. *Medicine* **2021**, *100*, e27012. [CrossRef] [PubMed]
75. Komatsu, M.; Kinoshita, T.; Akimoto, E.; Yoshida, M.; Nagata, H.; Habu, T.; Okayama, T.; Yura, M. Advantages of Robotic Gastrectomy for Overweight Patients with Gastric Cancer: A Comparison Study of Robotic Gastrectomy and Conventional Laparoscopic Gastrectomy. *Surg. Today* **2023**, *53*, 1260–1268. [CrossRef] [PubMed]

76. Huang, W.; Tang, G.; Sun, H. Robotic vs. Laparoscopic Gastrectomy for Patients with Locally Advanced Gastric Cancer: A Meta-Analysis of Randomized Controlled Trials and Propensity-Score-Matched Studies. *Int. J. Surg.* **2025**, *111*, 2240–2256. [CrossRef] [PubMed]
77. Ayabe, R.I.; Azimuddin, A.; Tran Cao, H.S. Robot-Assisted Liver Resection: The Real Benefit so Far. *Langenbeck's Arch. Surg.* **2022**, *407*, 1779–1787. [CrossRef]
78. Ziogas, I.A.; Giannis, D.; Esagian, S.M.; Economopoulos, K.P.; Tohme, S.; Geller, D.A. Laparoscopic versus Robotic Major Hepatectomy: A Systematic Review and Meta-Analysis. *Surg. Endosc.* **2021**, *35*, 524–535. [CrossRef]
79. Kamarajah, S.K.; Bundred, J.; Manas, D.; Jiao, L.; Hilal, M.A.; White, S.A. Robotic versus Conventional Laparoscopic Liver Resections: A Systematic Review and Meta-Analysis. *Scand. J. Surg.* **2021**, *110*, 290–300. [CrossRef]
80. Wang, P. Robotic versus Laparoscopic Hepatectomy: Meta-Analysis of Propensity-Score Matched Studies. *BJS Open* **2025**, *9*, zrae141. [CrossRef]
81. Del Angel Millan, G.; Cassese, G.; Giannone, F.; Del Basso, C.; Alagia, M.; Lodin, M.; Monsellato, I.; Palucci, M.; Sangiuolo, F.; Panaro, F. Postoperative Outcomes After Robotic Liver Resection of Caudate Lobe: A Systematic Review. *Medicina* **2024**, *61*, 34. [CrossRef]
82. Giannone, F.; Cassese, G.; Del Basso, C.; Alagia, M.; Palucci, M.; Sangiuolo, F.; Panaro, F. Robotic versus Laparoscopic Liver Resection for Difficult Posterosuperior Segments: A Systematic Review with a Meta-Analysis of Propensity-Score Matched Studies. *Surg. Endosc.* **2025**, *39*, 64–76. [CrossRef]
83. Troisi, R.I.; Pegoraro, F.; Giglio, M.C.; Rompianesi, G.; Berardi, G.; Tomassini, F.; De Simone, G.; Aprea, G.; Montalti, R.; De Palma, G.D. Robotic Approach to the Liver: Open Surgery in a Closed Abdomen or Laparoscopic Surgery with Technical Constraints? *Surg. Oncol.* **2020**, *33*, 239–248. [CrossRef]
84. Zhang, R.; Liu, S.; Li, T.; Zhan, J. Efficacy of Robot-Assisted Hepaticojejunostomy and Laparoscopic-Assisted Hepaticojejunostomy in Pediatric Congenital Choledochal Dilatation: A System Review and Meta-Analysis. *Pediatr. Surg. Int.* **2022**, *39*, 46. [CrossRef]
85. Wang, J.-M.; Li, J.-F.; Yuan, G.-D.; He, S.-Q. Robot-Assisted versus Laparoscopic Minor Hepatectomy: A Systematic Review and Meta-Analysis. *Medicine* **2021**, *100*, e25648. [CrossRef]
86. Coletta, D.; Levi Sandri, G.B.; Giuliani, G.; Guerra, F. Robot-assisted versus Conventional Laparoscopic Major Hepatectomies: Systematic Review with Meta-analysis. *Int. J. Med. Robot.* **2021**, *17*, e2218. [CrossRef]
87. Di Benedetto, F.; Petrowsky, H.; Magistri, P.; Halazun, K.J. Robotic Liver Resection: Hurdles and Beyond. *Int. J. Surg.* **2020**, *82*, 155–162. [CrossRef] [PubMed]
88. Magistri, P.; Tarantino, G.; Assirati, G.; Olivieri, T.; Catellani, B.; Guerrini, G.P.; Ballarin, R.; Di Benedetto, F. Robotic Liver Resection for Hepatocellular Carcinoma: A Systematic Review. *Int. J. Med. Robot.* **2019**, *15*, e2004. [CrossRef] [PubMed]
89. Niu, F.; Wang, Y.; Bai, Z.; He, Z.; Wang, H.; Li, F. An Updated Meta-Analysis of the Efficacy and Safety of Robot-Assisted Laparoscopy Hepatectomy and Laparoscopic Hepatectomy in the Treatment of Liver Tumors. *Medicine* **2025**, *104*, e40866. [CrossRef] [PubMed]
90. Mao, B.; Zhu, S.; Li, D.; Xiao, J.; Wang, B.; Yan, Y. Comparison of Safety and Effectiveness between Robotic and Laparoscopic Major Hepatectomy: A Systematic Review and Meta-Analysis. *Int. J. Surg.* **2023**, *109*, 2383–2391. [CrossRef]
91. Machairas, N.; Papaconstantinou, D.; Tsilimigras, D.I.; Moris, D.; Prodromidou, A.; Paspala, A.; Spartalis, E.; Kostakis, I.D. Comparison between Robotic and Open Liver Resection: A Systematic Review and Meta-Analysis of Short-Term Outcomes. *Updates Surg.* **2019**, *71*, 39–48. [CrossRef] [PubMed]
92. Guan, R.; Chen, Y.; Yang, K.; Ma, D.; Gong, X.; Shen, B.; Peng, C. Clinical Efficacy of Robot-Assisted versus Laparoscopic Liver Resection: A Meta Analysis. *Asian J. Surg.* **2019**, *42*, 19–31. [CrossRef] [PubMed]
93. Ciria, R.; Berardi, G.; Alconchel, F.; Briceño, J.; Choi, G.H.; Wu, Y.; Sugioka, A.; Troisi, R.I.; Salloum, C.; Soubrane, O.; et al. The Impact of Robotics in Liver Surgery: A Worldwide Systematic Review and Short-term Outcomes Meta-analysis on 2,728 Cases. *J. Hepatobiliary Pancreat. Sci.* **2022**, *29*, 181–197. [CrossRef] [PubMed]
94. Becker, F.; Morgül, H.; Katou, S.; Juratli, M.; Hölzen, J.P.; Pascher, A.; Struecker, B. Robotic Liver Surgery—Current Standards and Future Perspectives. *Z. Gastroenterol.* **2021**, *59*, 56–62. [CrossRef]
95. Koh, Y.X.; Zhao, Y.; Tan, I.E.-H.; Tan, H.L.; Chua, D.W.; Loh, W.-L.; Tan, E.K.; Teo, J.Y.; Au, M.K.H.; Goh, B.K.P. Comparative Cost-Effectiveness of Open, Laparoscopic, and Robotic Liver Resection: A Systematic Review and Network Meta-Analysis. *Surgery* **2024**, *176*, 11–23. [CrossRef]
96. Ziogas, I.A.; Evangeliou, A.P.; Mylonas, K.S.; Athanasiadis, D.I.; Cherouveim, P.; Geller, D.A.; Schulick, R.D.; Alexopoulos, S.P.; Tsoulfas, G. Economic Analysis of Open versus Laparoscopic versus Robotic Hepatectomy: A Systematic Review and Meta-Analysis. *Eur. J. Health Econ.* **2021**, *22*, 585–604. [CrossRef]
97. Hu, Y.; Guo, K.; Xu, J.; Xia, T.; Wang, T.; Liu, N.; Fu, Y. Robotic versus Laparoscopic Hepatectomy for Malignancy: A Systematic Review and Meta-Analysis. *Asian J. Surg.* **2021**, *44*, 615–628. [CrossRef]
98. Xuea, Q.; Wua, J.; Leia, Z.; Wanga, Q.; Fua, J.; Gaoa, F. Robot-Assisted versus Open Hepatectomy for Liver Tumors: Systematic Review and Meta-Analysis. *J. Chin. Med. Assoc.* **2023**, *86*, 282–288. [CrossRef]

99. Wong, D.J.; Wong, M.J.; Choi, G.H.; Wu, Y.M.; Lai, P.B.; Goh, B.K.P. Systematic Review and Meta-analysis of Robotic versus Open Hepatectomy. *ANZ J. Surg.* **2019**, *89*, 165–170. [CrossRef]
100. Gavriilidis, P.; Roberts, K.J.; Aldrighetti, L.; Sutcliffe, R.P. A Comparison between Robotic, Laparoscopic and Open Hepatectomy: A Systematic Review and Network Meta-Analysis. *Eur. J. Surg. Oncol.* **2020**, *46*, 1214–1224. [CrossRef]
101. He, Z.-Q.; Mao, Y.-L.; Lv, T.-R.; Liu, F.; Li, F.-Y. A Meta-Analysis between Robotic Hepatectomy and Conventional Open Hepatectomy. *J. Robot. Surg.* **2024**, *18*, 166. [CrossRef]
102. Gao, F.; Zhao, X.; Xie, Q.; Jiang, K.; Mao, T.; Yang, M.; Wu, H. Comparison of Short-Term Outcomes between Robotic and Laparoscopic Liver Resection: A Meta-Analysis of Propensity Score-Matched Studies. *Int. J. Surg.* **2023**, *109*, 3274–3282. [CrossRef]
103. Hu, L.; Yao, L.; Li, X.; Jin, P.; Yang, K.; Guo, T. Effectiveness and Safety of Robotic-Assisted versus Laparoscopic Hepatectomy for Liver Neoplasms: A Meta-Analysis of Retrospective Studies. *Asian J. Surg.* **2018**, *41*, 401–416. [CrossRef]
104. Long, Z.; Li, H.; Liang, H.; Wu, Y.; Ameer, S.; Qu, X.; Xiang, Z.; Wang, Q.; Dai, X.; Zhu, Z. Robotic versus Laparoscopic Liver Resection for Liver Malignancy: A Systematic Review and Meta-Analysis of Propensity Score-Matched Studies. *Surg. Endosc.* **2024**, *38*, 56–65. [CrossRef]
105. Hajibandeh, S.; Hajibandeh, S.; Dosis, A.; Qayum, M.K.; Hassan, K.; Kausar, A.; Satyadas, T. Level 2a Evidence Comparing Robotic versus Laparoscopic Left Lateral Hepatic Sectionectomy: A Meta-Analysis. *Langenbeck's Arch. Surg.* **2022**, *407*, 479–489. [CrossRef]
106. Yeow, M.; Soh, S.; Starkey, G.; Perini, M.V.; Koh, Y.-X.; Tan, E.-K.; Chan, C.-Y.; Raj, P.; Goh, B.K.P.; Kabir, T. A Systematic Review and Network Meta-Analysis of Outcomes after Open, Mini-Laparotomy, Hybrid, Totally Laparoscopic, and Robotic Living Donor Right Hepatectomy. *Surgery* **2022**, *172*, 741–750. [CrossRef]
107. Zhang, L.; Yuan, Q.; Xu, Y.; Wang, W. Comparative Clinical Outcomes of Robot-Assisted Liver Resection versus Laparoscopic Liver Resection: A Meta-Analysis. *PLoS ONE* **2020**, *15*, e0240593. [CrossRef]
108. Gheza, F.; Esposito, S.; Gruessner, S.; Mangano, A.; Fernandes, E.; Giulianotti, P.C. Reasons for Open Conversion in Robotic Liver Surgery: A Systematic Review with Pooled Analysis of More than 1000 Patients. *Int. J. Med. Robot.* **2019**, *15*, e1976. [CrossRef]
109. Linn, Y.; Wu, A.G.; Han, H.; Liu, R.; Chen, K.; Fuks, D.; Soubrane, O.; Cherqui, D.; Geller, D.; Cheung, T.; et al. Systematic Review and Meta-analysis of Difficulty Scoring Systems for Laparoscopic and Robotic Liver Resections. *J. Hepatobiliary Pancreat. Sci.* **2023**, *30*, 36–59. [CrossRef]
110. Wang, J.; Li, Z.; Chen, L.-L.; Zhao, J.-B.; Wu, J.-L.; Leng, Z.-W. Comparing Robotic and Open Surgical Techniques in Gallbladder Cancer Management: A Detailed Systematic Review and Meta-Analysis. *J. Robot. Surg.* **2024**, *18*, 111. [CrossRef]
111. Straatman, J.; Pucher, P.H.; Knight, B.C.; Carter, N.C.; Glaysher, M.A.; Mercer, S.J.; Van Boxel, G.I. Systematic Review: Robot-Assisted versus Conventional Laparoscopic Multiport Cholecystectomy. *J. Robot. Surg.* **2023**, *17*, 1967–1977. [CrossRef]
112. Chang, K.; Gokcal, F.; Kudsi, O.Y. Robotic Biliary Surgery. *Surg. Clin. N. Am.* **2020**, *100*, 283–302. [CrossRef]
113. Migliore, M.; Arezzo, A.; Arolfo, S.; Passera, R.; Morino, M. Safety of Single-Incision Robotic Cholecystectomy for Benign Gallbladder Disease: A Systematic Review. *Surg. Endosc.* **2018**, *32*, 4716–4727. [CrossRef]
114. Zhang, Y.; Liu, S.; Yang, Q.; Sun, R.; Liu, J.; Meng, Y.; Zhan, J. Comparison of Different Kasai Portoenterostomy Techniques in the Outcomes of Biliary Atresia: A Systematic Review and Network Meta-Analysis. *Pediatr. Surg. Int.* **2024**, *41*, 6. [CrossRef]
115. Mellado, S.; Chirban, A.M.; Shapera, E.; Rivera, B.; Panettieri, E.; Vivanco, M.; Conrad, C.; Sucandy, I.; Vega, E.A. Innovations in Surgery for Gallbladder Cancer: A Review of Robotic Surgery as a Feasible and Safe Option. *Am. J. Surg.* **2024**, *233*, 37–44. [CrossRef]
116. Cipriani, F.; Ratti, F.; Fiorentini, G.; Reineke, R.; Aldrighetti, L. Systematic Review of Perioperative and Oncologic Outcomes of Minimally-Invasive Surgery for Hilar Cholangiocarcinoma. *Updates Surg.* **2021**, *73*, 359–377. [CrossRef]
117. Wu, J.; Wang, L.; Yu, F.; Wang, L.; Leng, Z. Robotic-Assisted Radical Resection versus Open Surgery for Cholangiocarcinoma: A Systematic Review and Meta-Analysis. *J. Robot. Surg.* **2024**, *18*, 201. [CrossRef]
118. Pacilli, M.; Sanchez-Velázquez, P.; Abad, M.; Luque, E.; Burdio, F.; Ielpo, B. Minimally Invasive Subtotal Cholecystectomy. What Surgeons Need to Know. *Updates Surg.* **2024**, *76*, 2709–2713. [CrossRef]
119. Delgado, L.M.; Pompeu, B.F.; Pasqualotto, E.; Magalhães, C.M.; Oliveira, A.F.M.; Kato, B.K.; Leme, L.F.P.; De Figueiredo, S.M.P. Robotic-Assisted Cholecystectomy versus Conventional Laparoscopic Cholecystectomy for Benign Gallbladder Disease: A Systematic Review and Meta-Analysis. *J. Robot. Surg.* **2024**, *18*, 242. [CrossRef]
120. Han, C.; Shan, X.; Yao, L.; Yan, P.; Li, M.; Hu, L.; Tian, H.; Jing, W.; Du, B.; Wang, L.; et al. Robotic-Assisted versus Laparoscopic Cholecystectomy for Benign Gallbladder Diseases: A Systematic Review and Meta-Analysis. *Surg. Endosc.* **2018**, *32*, 4377–4392. [CrossRef]
121. Wang, W.; Fei, Y.; Liu, J.; Yu, T.; Tang, J.; Wei, F. Laparoscopic Surgery and Robotic Surgery for Hilar Cholangiocarcinoma: An Updated Systematic Review. *ANZ J. Surg.* **2021**, *91*, 42–48. [CrossRef]
122. Hu, H.; Wu, Z.; Jin, Y.; Ma, W.; Yang, Q.; Wang, J.; Liu, F.; Li, F. Minimally Invasive Surgery for Hilar Cholangiocarcinoma: State of Art and Future Perspectives. *ANZ J. Surg.* **2019**, *89*, 476–480. [CrossRef]

123. Tang, W.; Qiu, J.-G.; Deng, X.; Liu, S.-S.; Cheng, L.; Liu, J.-R.; Du, C.-Y. Minimally Invasive versus Open Radical Resection Surgery for Hilar Cholangiocarcinoma: Comparable Outcomes Associated with Advantages of Minimal Invasiveness. *PLoS ONE* **2021**, *16*, e0248534. [CrossRef]
124. Wang, W.; Sun, X.; Wei, F. Laparoscopic Surgery and Robotic Surgery for Single-Incision Cholecystectomy: An Updated Systematic Review. *Updates Surg.* **2021**, *73*, 2039–2046. [CrossRef]
125. Cubisino, A.; Dreifuss, N.H.; Cassese, G.; Bianco, F.M.; Panaro, F. Minimally Invasive Biliary Anastomosis after Iatrogenic Bile Duct Injury: A Systematic Review. *Updates Surg.* **2023**, *75*, 31–39. [CrossRef]
126. Sanford, D.E. An Update on Technical Aspects of Cholecystectomy. *Surg. Clin. N. Am.* **2019**, *99*, 245–258. [CrossRef]
127. Chee, M.Y.M.; Wu, A.G.R.; Fong, K.-Y.; Yew, A.; Koh, Y.X.; Goh, B.K.P. Robotic, Laparoscopic and Open Surgery for Gallbladder Cancer: A Systematic Review and Network Meta-Analysis. *Surg. Endosc.* **2024**, *38*, 4846–4857. [CrossRef]
128. Sun, N.; Zhang, J.L.; Zhang, C.S.; Li, X.H.; Shi, Y. Single-Incision Robotic Cholecystectomy versus Single-Incision Laparoscopic Cholecystectomy: A Systematic Review and Meta-Analysis. *Medicine* **2018**, *97*, e12103. [CrossRef]
129. Sun, N.; Zhang, J.; Zhang, C.; Shi, Y. Single-Site Robotic Cholecystectomy versus Multi-Port Laparoscopic Cholecystectomy: A Systematic Review and Meta-Analysis. *Am. J. Surg.* **2018**, *216*, 1205–1211. [CrossRef]
130. Shenoy, R.; Mederos, M.A.; Ye, L.; Mak, S.S.; Begashaw, M.M.; Booth, M.S.; Shekelle, P.G.; Wilson, M.; Gunnar, W.; Maggard-Gibbons, M.; et al. Intraoperative and Postoperative Outcomes of Robot-Assisted Cholecystectomy: A Systematic Review. *Syst. Rev.* **2021**, *10*, 124. [CrossRef]
131. Dong, S.; Jiang, A.; An, S.; Xiao, J. Comparison of Robot-Assisted, Open, and Laparoscopic-Assisted Surgery for Cholangiocarcinoma: A Network Meta-Analysis. *Langenbeck's Arch. Surg.* **2024**, *409*, 336. [CrossRef]
132. Hu, M.; Xu, D.; Zhang, Y.; Li, A.; Li, X.; Huang, J. Efficacy and Safety of Robotic Surgery versus Open Surgery for Hilar Cholangiocarcinoma: A Systematic Review and Meta-Analysis. *Int. J. Surg.* **2025**, *111*, 1301–1310. [CrossRef]
133. Liu, F.; Wu, Z.; Hu, H.; Jin, Y.; Ma, W.; Wang, J.; Li, F. Current Status and Future Perspectives of Minimally Invasive Surgery in Gallbladder Carcinoma. *ANZ J. Surg.* **2021**, *91*, 264–268. [CrossRef]
134. Lin, H.; Zhang, J.; Li, X.; Li, Y.; Su, S. Comparative Outcomes of Single-Incision Laparoscopic, Mini-Laparoscopic, Four-Port Laparoscopic, Three-Port Laparoscopic, and Single-Incision Robotic Cholecystectomy: A Systematic Review and Network Meta-Analysis. *Updates Surg.* **2023**, *75*, 41–51. [CrossRef]
135. Nam, C.; Lee, J.S.; Kim, J.S.; Lee, T.Y.; Yoon, Y.C. Evolution of Minimally Invasive Cholecystectomy: A Narrative Review. *BMC Surg.* **2024**, *24*, 378.
136. Kirkham, E.N.; Jones, C.S.; Higginbotham, G.; Biggs, S.; Dewi, F.; Dixon, L.; Huttman, M.; Main, B.G.; Ramirez, J.; Robertson, H.; et al. Quality of Reporting of Robot-Assisted Cholecystectomy in Relation to the IDEAL Recommendations: Systematic Review. *BJS Open* **2022**, *6*, zrac116. [CrossRef]
137. Franken, L.C.; Van Der Poel, M.J.; Latenstein, A.E.J.; Zwart, M.J.; Roos, E.; Busch, O.R.; Besselink, M.G.; Van Gulik, T.M. Minimally Invasive Surgery for Perihilar Cholangiocarcinoma: A Systematic Review. *J. Robot. Surg.* **2019**, *13*, 717–727. [CrossRef] [PubMed]
138. Jensen, S.A.-M.S.; Fonnes, S.; Gram-Hanssen, A.; Andresen, K.; Rosenberg, J. Low Long-Term Incidence of Incisional Hernia after Cholecystectomy: A Systematic Review with Meta-Analysis. *Surgery* **2021**, *169*, 1268–1277. [CrossRef]
139. Kossenas, K.; Kalomoiris, D.; Georgopoulos, F. Single-Port Robotic versus Single-Incision Laparoscopic Cholecystectomy in Patients with BMI $\geq$ 25 Kg/M2: A Systematic Review and Meta-Analysis. *J. Robot. Surg.* **2024**, *19*, 2. [CrossRef]
140. Li, P.; Zhang, H.; Chen, L.; Liu, T.; Dai, M. Robotic versus Laparoscopic Distal Pancreatectomy on Perioperative Outcomes: A Systematic Review and Meta-Analysis. *Updates Surg.* **2023**, *75*, 7–21. [CrossRef]
141. Kamarajah, S.K.; Sutandi, N.; Robinson, S.R.; French, J.J.; White, S.A. Robotic versus Conventional Laparoscopic Distal Pancreatic Resection: A Systematic Review and Meta-Analysis. *HPB* **2019**, *21*, 1107–1118. [CrossRef]
142. Da Dong, X.; Felsenreich, D.M.; Gogna, S.; Rojas, A.; Zhang, E.; Dong, M.; Azim, A.; Gachabayov, M. Robotic Pancreaticoduodenectomy Provides Better Histopathological Outcomes as Compared to Its Open Counterpart: A Meta-Analysis. *Sci. Rep.* **2021**, *11*, 3774. [CrossRef] [PubMed]
143. Kamarajah, S.K.; Bundred, J.R.; Marc, O.S.; Jiao, L.R.; Hilal, M.A.; Manas, D.M.; White, S.A. A Systematic Review and Network Meta-Analysis of Different Surgical Approaches for Pancreaticoduodenectomy. *HPB* **2020**, *22*, 329–339. [CrossRef]
144. Kamarajah, S.K.; Bundred, J.; Marc, O.S.; Jiao, L.R.; Manas, D.; Abu Hilal, M.; White, S.A. Robotic versus Conventional Laparoscopic Pancreaticoduodenectomy a Systematic Review and Meta-Analysis. *Eur. J. Surg. Oncol.* **2020**, *46*, 6–14. [CrossRef]
145. Kabir, T.; Tan, H.L.; Syn, N.L.; Wu, E.J.; Kam, J.H.; Goh, B.K.P. Outcomes of Laparoscopic, Robotic, and Open Pancreatoduodenectomy: A Network Meta-Analysis of Randomized Controlled Trials and Propensity-Score Matched Studies. *Surgery* **2022**, *171*, 476–489. [CrossRef]
146. Shyr, Y.-M.; Wang, S.-E.; Chen, S.-C.; Shyr, B.-U. Robotic Pancreaticoduodenectomy in the Era of Minimally Invasive Surgery. *J. Chin. Med. Assoc.* **2020**, *83*, 639–643. [CrossRef] [PubMed]

147. Luo, Y.; Yang, T.-Y.; Li, W.; Yu, Q.-J.; Xia, X.; Lin, Z.-Y.; Chen, R.-D.; Cheng, L. Perioperative and Oncologic Outcomes of Robot-Assisted versus Open Surgery for Pancreatic Ductal Adenocarcinoma: A Systematic Review and Meta-Analysis. *J. Robot. Surg.* **2024**, *18*, 288. [CrossRef] [PubMed]
148. Lee, S.; Varghese, C.; Fung, M.; Patel, B.; Pandanaboyana, S.; Dasari, B.V.M. Systematic Review and Meta-Analysis of Cost-Effectiveness of Minimally Invasive versus Open Pancreatic Resections. *Langenbeck's Arch. Surg.* **2023**, *408*, 306. [CrossRef]
149. Koh, Y.X.; Zhao, Y.; Tan, I.E.-H.; Tan, H.L.; Chua, D.W.; Loh, W.-L.; Tan, E.K.; Teo, J.Y.; Au, M.K.H.; Goh, B.K.P. Evaluating the Economic Efficiency of Open, Laparoscopic, and Robotic Distal Pancreatectomy: An Updated Systematic Review and Network Meta-Analysis. *Surg. Endosc.* **2024**, *38*, 3035–3051. [CrossRef]
150. Xu, S.-B.; Jia, C.-K.; Wang, J.-R.; Zhang, R.; Mou, Y.-P. Do Patients Benefit More from Robot Assisted Approach than Conventional Laparoscopic Distal Pancreatectomy? A Meta-Analysis of Perioperative and Economic Outcomes. *J. Formos. Med. Assoc.* **2019**, *118*, 268–278. [CrossRef]
151. Chaouch, M.A.; Gouader, A.; Mazzotta, A.; Costa, A.C.; Krimi, B.; Rahbari, N.; Mehrabi, A.; Reissfelder, C.; Soubrane, O.; Oweira, H. Robotic versus Open Total Pancreatectomy: A Systematic Review and Meta-Analysis. *J. Robot. Surg.* **2023**, *17*, 1259–1270. [CrossRef]
152. Van Ramshorst, T.M.E.; Van Bodegraven, E.A.; Zampedri, P.; Kasai, M.; Besselink, M.G.; Abu Hilal, M. Robot-Assisted versus Laparoscopic Distal Pancreatectomy: A Systematic Review and Meta-Analysis Including Patient Subgroups. *Surg. Endosc.* **2023**, *37*, 4131–4143. [CrossRef]
153. Mavrovounis, G.; Diamantis, A.; Perivoliotis, K.; Volakakis, G.; Tepetes, K. Laparoscopic versus Robotic Peripheral Pancreatectomy: A Systematic Review and Meta-Analysis. *J. BUON* **2020**, *25*, 2456–2475.
154. Rompianesi, G.; Montalti, R.; Giglio, M.C.; Caruso, E.; Ceresa, C.D.; Troisi, R.I. Robotic Central Pancreatectomy: A Systematic Review and Meta-Analysis. *HPB* **2022**, *24*, 143–151. [CrossRef]
155. Mantzavinou, A.; Uppara, M.; Chan, J.; Patel, B. Robotic versus Open Pancreaticoduodenectomy, Comparing Therapeutic Indexes; a Systematic Review. *Int. J. Surg.* **2022**, *101*, 106633. [CrossRef]
156. Farrarons, S.S.; Van Bodegraven, E.A.; Sauvanet, A.; Hilal, M.A.; Besselink, M.G.; Dokmak, S. Minimally Invasive versus Open Central Pancreatectomy: Systematic Review and Meta-Analysis. *Surgery* **2022**, *172*, 1490–1501. [CrossRef] [PubMed]
157. Roesel, R.; Bernardi, L.; Bonino, M.A.; Popeskou, S.G.; Garofalo, F.; Cristaudi, A. Minimally-Invasive versus Open Pancreatic Enucleation: Systematic Review and Metanalysis of Short-Term Outcomes. *HPB* **2023**, *25*, 603–613. [CrossRef] [PubMed]
158. Dalla Valle, R.; Cremaschi, E.; Lamecchi, L.; Guerini, F.; Rosso, E.; Iaria, M. Open and Minimally Invasive Pancreatic Neoplasms Enucleation: A Systematic Review. *Surg. Endosc.* **2019**, *33*, 3192–3199. [CrossRef] [PubMed]
159. Neshan, M.; Padmanaban, V.; Chick, R.C.; Pawlik, T.M. Open vs Robotic-Assisted Pancreaticoduodenectomy, Cost-Effectiveness and Long-Term Oncologic Outcomes: A Systematic Review and Meta-Analysis. *J. Gastrointest. Surg.* **2024**, *28*, 1933–1942. [CrossRef]
160. Zhang, W.; Huang, Z.; Zhang, J.; Che, X. Safety and Efficacy of Robot-Assisted versus Open Pancreaticoduodenectomy: A Meta-Analysis of Multiple Worldwide Centers. *Updates Surg.* **2021**, *73*, 893–907. [CrossRef]
161. Aiolfi, A.; Lombardo, F.; Bonitta, G.; Danelli, P.; Bona, D. Systematic Review and Updated Network Meta-Analysis Comparing Open, Laparoscopic, and Robotic Pancreaticoduodenectomy. *Updates Surg.* **2021**, *73*, 909–922. [CrossRef] [PubMed]
162. Zhou, J.; Lv, Z.; Zou, H.; Xiong, L.; Liu, Z.; Chen, W.; Wen, Y. Up-to-Date Comparison of Robotic-Assisted versus Open Distal Pancreatectomy: A PRISMA-Compliant Meta-Analysis. *Medicine* **2020**, *99*, e20435. [CrossRef] [PubMed]
163. Uijterwijk, B.A.; Wei, K.; Kasai, M.; Ielpo, B.; Hilst, J.V.; Chinnusamy, P.; Lemmers, D.H.L.; Burdio, F.; Senthilnathan, P.; Besselink, M.G.; et al. Minimally Invasive versus Open Pancreatoduodenectomy for Pancreatic Ductal Adenocarcinoma: Individual Patient Data Meta-Analysis of Randomized Trials. *Eur. J. Surg. Oncol.* **2023**, *49*, 1351–1361. [CrossRef]
164. Gavriilidis, P.; Roberts, K.J.; Sutcliffe, R.P. Comparison of Robotic vs Laparoscopic vs Open Distal Pancreatectomy. A Systematic Review and Network Meta-Analysis. *HPB* **2019**, *21*, 1268–1276. [CrossRef]
165. Partelli, S.; Ricci, C.; Cinelli, L.; Montorsi, R.M.; Ingaldi, C.; Andreasi, V.; Crippa, S.; Alberici, L.; Casadei, R.; Falconi, M. Evaluation of Cost-Effectiveness among Open, Laparoscopic and Robotic Distal Pancreatectomy: A Systematic Review and Meta-Analysis. *Am. J. Surg.* **2021**, *222*, 513–520. [CrossRef]
166. Di Martino, M.; Caruso, R.; D'Ovidio, A.; Núñez-Alfonsel, J.; Burdió Pinilla, F.; Quijano Collazo, Y.; Vicente, E.; Ielpo, B. Robotic versus Laparoscopic Distal Pancreatectomies: A Systematic Review and Meta-analysis on Costs and Perioperative Outcome. *Int. J. Med. Robot.* **2021**, *17*, e2295. [CrossRef]
167. Wang, K.; Dong, S.; Zhang, W.; Ni, Y.; Xie, F.; Wang, J.; Wang, X.; Li, Y. Surgical Methods Influence on the Risk of Anastomotic Fistula after Pancreaticoduodenectomy: A Systematic Review and Network Meta-Analysis. *Surg. Endosc.* **2023**, *37*, 3380–3397. [CrossRef] [PubMed]
168. Yan, Q.; Xu, L.; Ren, Z.; Liu, C. Robotic versus Open Pancreaticoduodenectomy: A Meta-Analysis of Short-Term Outcomes. *Surg. Endosc.* **2020**, *34*, 501–509. [CrossRef]

169. Podda, M.; Gerardi, C.; Di Saverio, S.; Marino, M.V.; Davies, R.J.; Pellino, G.; Pisanu, A. Robotic-Assisted versus Open Pancreaticoduodenectomy for Patients with Benign and Malignant Periampullary Disease: A Systematic Review and Meta-Analysis of Short-Term Outcomes. *Surg. Endosc.* **2020**, *34*, 2390–2409. [CrossRef]
170. Armengol-García, C.; Blandin-Alvarez, V.; Sharma, E.; Salinas-Ruiz, L.E.; González-Méndez, M.L.; Monteiro Dos Santos, M.; Farhan-Sayudo, I.; Ventura De Santana De Jesus, A.C.; Rizwan-Ahmed, A.; Flores-Villalba, E. Perioperative Outcomes of Robotic vs Laparoscopic Pancreatoduodenectomy: A Meta-Analysis and Trial Sequential Analysis. *Surg. Endosc.* **2025**, *39*, 1462–1472. [CrossRef]
171. Zhao, W.; Liu, C.; Li, S.; Geng, D.; Feng, Y.; Sun, M. Safety and Efficacy for Robot-Assisted versus Open Pancreaticoduodenectomy and Distal Pancreatectomy: A Systematic Review and Meta-Analysis. *Surg. Oncol.* **2018**, *27*, 468–478. [CrossRef] [PubMed]
172. Tang, G.; Zhang, J.; Zhang, L.; Xia, L.; Chen, R.; Zhou, R. Postoperative Complications and Surgical Outcomes of Robotic versus Laparoscopic Pancreaticoduodenectomy: A Meta-Analysis of Propensity-Score-Matched Studies. *Int. J. Surg.* **2025**, *111*, 2257–2272. [CrossRef] [PubMed]
173. Xu, W.-Y.; Xin, J.; Yang, Y.; Wang, Q.-W.; Yuan, B.-H.; Peng, F.-X. A Comprehensive Analysis of Robotic Assisted vs. Laparoscopic Distal Pancreatectomy Using Propensity Score Matching. *J. Robot. Surg.* **2025**, *19*, 86. [CrossRef] [PubMed]
174. Hu, Y.; Qin, Y.; Yu, D.; Li, X.; Zhao, Y.; Kong, D.; Jin, W.; Wang, H. Meta-Analysis of Short-Term Outcomes Comparing Robot-Assisted and Laparoscopic Distal Pancreatectomy. *J. Comp. Eff. Res.* **2020**, *9*, 201–218. [CrossRef]
175. Lyu, Y.; Cheng, Y.; Wang, B.; Zhao, S.; Chen, L. Comparison of 3 Minimally Invasive Methods Versus Open Distal Pancreatectomy: A Systematic Review and Network Meta-Analysis. *Surg. Laparosc. Endosc. Percutaneous Tech.* **2021**, *31*, 104–112. [CrossRef]
176. Niu, X.; Yu, B.; Yao, L.; Tian, J.; Guo, T.; Ma, S.; Cai, H. Comparison of Surgical Outcomes of Robot-Assisted Laparoscopic Distal Pancreatectomy versus Laparoscopic and Open Resections: A Systematic Review and Meta-Analysis. *Asian J. Surg.* **2019**, *42*, 32–45. [CrossRef]
177. Kossenas, K.; Kouzeiha, R.; Moutzouri, O.; Georgopoulos, F. Comparing the Operative, Oncological, Post-Operative Outcomes and Complications of Robotic and Laparoscopic Pancreaticoduodenectomy for the Treatment of Pancreatic and Periampullary Cancers: A Systematic Review and Meta-Analysis with Subgroup Analysis. *J. Robot. Surg.* **2025**, *19*, 97. [CrossRef]
178. Chaouch, M.A.; Hussain, M.I.; Carneiro Da Costa, A.; Mazzotta, A.; Krimi, B.; Gouader, A.; Cotte, E.; Khan, J.; Oweira, H. Robotic versus Laparoscopic Total Mesorectal Excision with Lateral Lymph Node Dissection for Advanced Rectal Cancer: A Systematic Review and Meta-Analysis. *PLoS ONE* **2024**, *19*, e0304031. [CrossRef]
179. Geitenbeek, R.T.J.; Burghgraef, T.A.; Moes, C.A.; Hompes, R.; Ranchor, A.V.; Consten, E.C.J.; the MIRECA study group; Van Acker, G.J.D.; Aukema, T.S.; Belgers, H.J.; et al. Functional Outcomes and Quality of Life Following Open versus Laparoscopic versus Robot-Assisted versus Transanal Total Mesorectal Excision in Rectal Cancer Patients: A Systematic Review and Meta-Analysis. *Surg. Endosc.* **2024**, *38*, 4431–4444. [CrossRef]
180. Chen, Y.-C.; Tsai, Y.-Y.; Ke, T.-W.; Shen, M.-Y.; Fingerhut, A.; Chen, W.T.-L. Robotic versus Laparoscopic Pelvic Lateral Lymph Node Dissection in Locally Advanced Rectal Cancer: A Systemic Review and Meta-Analysis. *Surg. Endosc.* **2024**, *38*, 3520–3530. [CrossRef]
181. Ishizuka, M.; Shibuya, N.; Hachiya, H.; Nishi, Y.; Kono, T.; Takayanagi, M.; Nemoto, T.; Ihara, K.; Shiraki, T.; Matsumoto, T.; et al. Robotic Surgery Is Associated with a Decreased Risk of Circumferential Resection Margin Positivity Compared with Conventional Laparoscopic Surgery in Patients with Rectal Cancer Undergoing Mesorectal Excision: A Systematic Review and Meta-Analysis. *Eur. J. Surg. Oncol.* **2024**, *50*, 108538. [CrossRef]
182. Flynn, J.; Larach, J.T.; Kong, J.C.H.; Warrier, S.K.; Heriot, A. Robotic versus Laparoscopic Ileal Pouch-Anal Anastomosis (IPAA): A Systematic Review and Meta-Analysis. *Int. J. Color. Dis.* **2021**, *36*, 1345–1356. [CrossRef]
183. Zaman, S.; Mohamedahmed, A.Y.Y.; Abdelrahman, W.; Abdalla, H.E.; Wuheb, A.A.; Issa, M.T.; Faiz, N.; Yassin, N.A. Minimally Invasive Surgery for Inflammatory Bowel Disease: A Systematic Review and Meta-Analysis of Robotic Versus Laparoscopic Surgical Techniques. *J. Crohn's Colitis* **2024**, *18*, 1342–1355. [CrossRef]
184. Chen, Z.; Du, Q.-L.; Zhu, Y.; Wang, H. A Systematic Review and Meta-Analysis of Short-Term Outcomes Comparing the Efficacy of Robotic versus Laparoscopic Colorectal Surgery in Obese Patients. *J. Robot. Surg.* **2024**, *18*, 167. [CrossRef] [PubMed]
185. Gavriilidis, P.; Wheeler, J.; Spinelli, A.; de'Angelis, N.; Simopoulos, C.; Di Saverio, S. Robotic vs Laparoscopic Total Mesorectal Excision for Rectal Cancers: Has a Paradigm Change Occurred? A Systematic Review by Updated Meta-analysis. *Color. Dis.* **2020**, *22*, 1506–1517. [CrossRef] [PubMed]
186. McKechnie, T.; Khamar, J.; Chu, C.; Hatamnejad, A.; Jessani, G.; Lee, Y.; Doumouras, A.; Amin, N.; Hong, D.; Eskicioglu, C. Robotic versus Laparoscopic Colorectal Surgery for Patients with Obesity: An Updated Systematic Review and Meta-analysis. *ANZ J. Surg.* **2025**, *95*, 675–689. [CrossRef]
187. Shen, Z.; Zhu, X.; Ruan, H.; Shen, J.; Zhu, M.; Huang, S. Comparison of Short-Term Outcomes of Laparoscopic Surgery, Robot-Assisted Laparoscopic Surgery, and Open Surgery for Lateral Lymph-Node Dissection for Rectal Cancer: A Network Meta-Analysis. *Updates Surg.* **2024**, *76*, 1151–1160. [CrossRef] [PubMed]

188. Ma, S.; Chen, Y.; Chen, Y.; Guo, T.; Yang, X.; Lu, Y.; Tian, J.; Cai, H. Short-Term Outcomes of Robotic-Assisted Right Colectomy Compared with Laparoscopic Surgery: A Systematic Review and Meta-Analysis. *Asian J. Surg.* **2019**, *42*, 589–598. [CrossRef]
189. Grass, J.K.; Chen, C.; Melling, N.; Lingala, B.; Kemper, M.; Scognamiglio, P.; Persiani, R.; Tirelli, F.; Caricato, M.; Capolupo, G.T.; et al. Robotic Rectal Resection Preserves Anorectal Function: Systematic Review and Meta-analysis. *Int. J. Med. Robot.* **2021**, *17*, e2329. [CrossRef]
190. Kowalewski, K.F.; Seifert, L.; Ali, S.; Schmidt, M.W.; Seide, S.; Haney, C.; Tapking, C.; Shamiyeh, A.; Kulu, Y.; Hackert, T.; et al. Functional Outcomes after Laparoscopic versus Robotic-Assisted Rectal Resection: A Systematic Review and Meta-Analysis. *Surg. Endosc.* **2021**, *35*, 81–95. [CrossRef]
191. Qiu, H.; Yu, D.; Ye, S.; Shan, R.; Ai, J.; Shi, J. Long-Term Oncological Outcomes in Robotic versus Laparoscopic Approach for Rectal Cancer: A Systematic Review and Meta-Analysis. *Int. J. Surg.* **2020**, *80*, 225–230. [CrossRef] [PubMed]
192. Tong, G.; Zhang, G.; Zheng, Z. Robotic and Robotic-Assisted vs Laparoscopic Rectal Cancer Surgery: A Meta-Analysis of Short-Term and Long-Term Results. *Asian J. Surg.* **2021**, *44*, 1549. [CrossRef] [PubMed]
193. Shi, H.; Yi, X.; Yan, X.; Wu, W.; Ouyang, H.; Chen, X. Meta-Analysis of the Efficacy and Safety of Robot-Assisted Comparative Laparoscopic Surgery in Lateral Lymph Node Dissection for Rectal Cancer. *Surg. Endosc.* **2024**, *38*, 5584–5595. [CrossRef] [PubMed]
194. Arang, H.; El Boghdady, M. Robotic Appendicectomy: A review of feasibility. *Sultan Qaboos Univ. Med. J.* **2023**, *23*, 440–446. [CrossRef]
195. Chok, A.Y.; Zhao, Y.; Tan, I.E.-H.; Au, M.K.H.; Tan, E.J.K.W. Cost-Effectiveness Comparison of Minimally Invasive, Robotic and Open Approaches in Colorectal Surgery: A Systematic Review and Bayesian Network Meta-Analysis of Randomized Clinical Trials. *Int. J. Color. Dis.* **2023**, *38*, 86. [CrossRef]
196. Geitenbeek, R.T.J.; Burghgraef, T.A.; Broekman, M.; Schop, B.P.A.; Lieverse, T.G.F.; Hompes, R.; Havenga, K.; Postma, M.J.; Consten, E.C.J. Economic Analysis of Open versus Laparoscopic versus Robot-Assisted versus Transanal Total Mesorectal Excision in Rectal Cancer Patients: A Systematic Review. *PLoS ONE* **2023**, *18*, e0289090. [CrossRef]
197. Kossenas, K.; Moutzouri, O.; Georgopoulos, F. Comparison of Short-Term Outcomes of Robotic versus Laparoscopic Right Colectomy for Patients $\geq$ 65 Years of Age: A Systematic Review and Meta-Analysis of Prospective Studies. *J. Robot. Surg.* **2025**, *19*, 60. [CrossRef]
198. Cuk, P.; Kjær, M.D.; Mogensen, C.B.; Nielsen, M.F.; Pedersen, A.K.; Ellebæk, M.B. Short-Term Outcomes in Robot-Assisted Compared to Laparoscopic Colon Cancer Resections: A Systematic Review and Meta-Analysis. *Surg. Endosc.* **2022**, *36*, 32–46. [CrossRef]
199. Fleming, C.A.; Cullinane, C.; Lynch, N.; Killeen, S.; Coffey, J.C.; Peirce, C.B. Urogenital Function Following Robotic and Laparoscopic Rectal Cancer Surgery: Meta-Analysis. *Br. J. Surg.* **2021**, *108*, 128–137. [CrossRef]
200. Tang, B.; Lei, X.; Ai, J.; Huang, Z.; Shi, J.; Li, T. Comparison of Robotic and Laparoscopic Rectal Cancer Surgery: A Meta-Analysis of Randomized Controlled Trials. *World J. Surg. Oncol.* **2021**, *19*, 38. [CrossRef]
201. Solaini, L.; Bocchino, A.; Avanzolini, A.; Annunziata, D.; Cavaliere, D.; Ercolani, G. Robotic versus Laparoscopic Left Colectomy: A Systematic Review and Meta-Analysis. *Int. J. Color. Dis.* **2022**, *37*, 1497–1507. [CrossRef]
202. Sun, X.-Y.; Xu, L.; Lu, J.-Y.; Zhang, G.-N. Robotic versus Conventional Laparoscopic Surgery for Rectal Cancer: Systematic Review and Meta-Analysis. *Minim. Invasive Ther. Allied Technol.* **2019**, *28*, 135–142. [CrossRef]
203. Wang, X.; Cao, G.; Mao, W.; Lao, W.; He, C. Robot-Assisted versus Laparoscopic Surgery for Rectal Cancer: A Systematic Review and Meta-Analysis. *J. Cancer Res. Ther.* **2020**, *16*, 979. [CrossRef]
204. Solaini, L.; Bazzocchi, F.; Cavaliere, D.; Avanzolini, A.; Cucchetti, A.; Ercolani, G. Robotic versus Laparoscopic Right Colectomy: An Updated Systematic Review and Meta-Analysis. *Surg. Endosc.* **2018**, *32*, 1104–1110. [CrossRef]
205. Holmer, C.; Kreis, M.E. Systematic Review of Robotic Low Anterior Resection for Rectal Cancer. *Surg. Endosc.* **2018**, *32*, 569–581. [CrossRef]
206. Zelhart, M.; Kaiser, A.M. Robotic versus Laparoscopic versus Open Colorectal Surgery: Towards Defining Criteria to the Right Choice. *Surg. Endosc.* **2018**, *32*, 24–38. [CrossRef] [PubMed]
207. Lee, S.H.; Kim, D.H.; Lim, S.W. Robotic versus Laparoscopic Intersphincteric Resection for Low Rectal Cancer: A Systematic Review and Meta-Analysis. *Int. J. Color. Dis.* **2018**, *33*, 1741–1753. [CrossRef] [PubMed]
208. Meyer, J.; Meyer, E.; Meurette, G.; Liot, E.; Toso, C.; Ris, F. Robotic versus Laparoscopic Right Hemicolectomy: A Systematic Review of the Evidence. *J. Robot. Surg.* **2024**, *18*, 116. [CrossRef]
209. Lam, J.; Tam, M.S.; Rettig, R.L.; McLemore, E.C. Robotic Versus Laparoscopic Surgery for Rectal Cancer: A Comprehensive Review of Oncological Outcomes. *Perm. J.* **2021**, *25*, 21.050. [CrossRef]
210. Genova, P.; Pantuso, G.; Cipolla, C.; Latteri, M.A.; Abdalla, S.; Paquet, J.-C.; Brunetti, F.; de'Angelis, N.; Di Saverio, S. Laparoscopic versus Robotic Right Colectomy with Extra-Corporeal or Intra-Corporeal Anastomosis: A Systematic Review and Meta-Analysis. *Langenbeck's Arch. Surg.* **2021**, *406*, 1317–1339. [CrossRef] [PubMed]

211. Rubinkiewicz, M.; Witowski, J.; Zbroja, K.; Rozmus, K.; Krzywoń, J.; Truszkiewicz, K. A Systematic Review and Meta-Analysis of Laparoscopic versus Robotic Rectal Surgery with Primary Anastomosis. *Pol. Przegl. Chir.* **2019**, *92*, 5–11. [CrossRef]
212. Yao, Q.; Sun, Q.-N.; Ren, J.; Wang, L.-H.; Wang, D.-R. Comparison of Robotic-assisted versus Conventional Laparoscopic Surgery for Mid–Low Rectal Cancer: A Systematic Review and Meta-Analysis. *J. Cancer Res. Clin. Oncol.* **2023**, *149*, 15207–15217. [CrossRef]
213. Gahunia, S.; Wyatt, J.; Powell, S.G.; Mahdi, S.; Ahmed, S.; Altaf, K. Robotic-Assisted versus Laparoscopic Surgery for Colorectal Cancer in High-Risk Patients: A Systematic Review and Meta-Analysis. *Tech. Coloproctol.* **2025**, *29*, 98. [CrossRef]
214. Li, H.; Xu, L.; Shen, X.; Li, X. The Perioperative Results of Robotic and Laparoscopic Surgery for Rectal Cancer in Obese Patients: A Systematic Review and Meta-Analysis. *World J. Surg. Oncol.* **2025**, *23*, 123. [CrossRef]
215. Morini, A.; Zizzo, M.; Zanelli, M.; Sanguedolce, F.; Palicelli, A.; Bonelli, C.; Mangone, L.; Fabozzi, M. Robotic versus Laparoscopic Colectomy for Transverse Colon Cancer: A Systematic Review and Meta-Analysis. *Int. J. Color. Dis.* **2025**, *40*, 79. [CrossRef]
216. Ng, K.T.; Tsia, A.K.V.; Chong, V.Y.L. Robotic Versus Conventional Laparoscopic Surgery for Colorectal Cancer: A Systematic Review and Meta-Analysis with Trial Sequential Analysis. *World J. Surg.* **2019**, *43*, 1146–1161. [CrossRef]
217. Albayati, S.; Chen, P.; Morgan, M.J.; Toh, J.W.T. Robotic vs. Laparoscopic Ventral Mesh Rectopexy for External Rectal Prolapse and Rectal Intussusception: A Systematic Review. *Tech. Coloproctol.* **2019**, *23*, 529–535. [CrossRef] [PubMed]
218. Rausa, E.; Kelly, M.E.; Asti, E.; Aiolfi, A.; Bonitta, G.; Bonavina, L. Right Hemicolectomy: A Network Meta-Analysis Comparing Open, Laparoscopic-Assisted, Total Laparoscopic, and Robotic Approach. *Surg. Endosc.* **2019**, *33*, 1020–1032. [CrossRef] [PubMed]
219. Giuliani, G.; Guerra, F.; Coletta, D.; Giuliani, A.; Salvischiani, L.; Tribuzi, A.; Caravaglios, G.; Genovese, A.; Coratti, A. Robotic versus Conventional Laparoscopic Technique for the Treatment of Left-Sided Colonic Diverticular Disease: A Systematic Review with Meta-Analysis. *Int. J. Color. Dis.* **2022**, *37*, 101–109. [CrossRef] [PubMed]
220. Prete, F.P.; Pezzolla, A.; Prete, F.; Testini, M.; Marzaioli, R.; Patriti, A.; Jimenez-Rodriguez, R.M.; Gurrado, A.; Strippoli, G.F.M. Robotic Versus Laparoscopic Minimally Invasive Surgery for Rectal Cancer: A Systematic Review and Meta-Analysis of Randomized Controlled Trials. *Ann. Surg.* **2018**, *267*, 1034–1046. [CrossRef] [PubMed]
221. Khan, M.H.; Tahir, A.; Hussain, A.; Monis, A.; Zahid, S.; Fatima, M. Outcomes of Robotic versus Laparoscopic-Assisted Surgery in Patients with Rectal Cancer: A Systematic Review and Meta-Analysis. *Langenbeck's Arch. Surg.* **2024**, *409*, 269. [CrossRef]
222. Waters, P.S.; Cheung, F.P.; Peacock, O.; Heriot, A.G.; Warrier, S.K.; O'Riordain, D.S.; Pillinger, S.; Lynch, A.C.; Stevenson, A.R.L. Successful Patient-oriented Surgical Outcomes in Robotic vs Laparoscopic Right Hemicolectomy for Cancer—A Systematic Review. *Color. Dis.* **2020**, *22*, 488–499. [CrossRef]
223. Wang, X.; Ma, R.; Hou, T.; Xu, H.; Zhang, C.; Ye, C. Robotic versus Laparoscopic Surgery for Colorectal Cancer in Older Patients: A Systematic Review and Meta-Analysis. *Minim. Invasive Ther. Allied Technol.* **2025**, *34*, 35–43. [CrossRef]
224. Hoshino, N.; Sakamoto, T.; Hida, K.; Sakai, Y. Robotic versus Laparoscopic Surgery for Rectal Cancer: An Overview of Systematic Reviews with Quality Assessment of Current Evidence. *Surg. Today* **2019**, *49*, 556–570. [CrossRef]
225. Abdelsamad, A.; Mohammed, M.K.; Serour, A.S.A.S.; Khalil, I.; Wesh, Z.M.; Rashidi, L.; Langenbach, M.R.; Gebauer, F.; Mohamed, K.A. Robotic-Assisted versus Laparoscopic-Assisted Extended Mesorectal Excision: A Comprehensive Meta-Analysis and Systematic Review of Perioperative and Long-Term Outcomes. *Surg. Endosc.* **2024**, *38*, 6464–6475. [CrossRef] [PubMed]
226. Simillis, C.; Lal, N.; Thoukididou, S.N.; Kontovounisios, C.; Smith, J.J.; Hompes, R.; Adamina, M.; Tekkis, P.P. Open Versus Laparoscopic Versus Robotic Versus Transanal Mesorectal Excision for Rectal Cancer: A Systematic Review and Network Meta-Analysis. *Ann. Surg.* **2019**, *270*, 59–68. [CrossRef] [PubMed]
227. Sheng, S.; Zhao, T.; Wang, X. Comparison of Robot-Assisted Surgery, Laparoscopic-Assisted Surgery, and Open Surgery for the Treatment of Colorectal Cancer: A Network Meta-Analysis. *Medicine* **2018**, *97*, e11817. [CrossRef]
228. Oweira, H.; Reissfelder, C.; Elhadedy, H.; Rahbari, N.; Mehrabi, A.; Fattal, W.; Khan, J.; Chaouch, M. Robotic Colectomy with CME versus Laparoscopic Colon Resection with or without CME for Colon Cancer: A Systematic Review and Meta-Analysis. *Ann. R. Coll. Surg. Engl.* **2023**, *105*, 113–125. [CrossRef] [PubMed]
229. Gonçalves, G.F.; Pereira, L.H.M.; Gurgel, S.E.; Rêgo, A.C.M.; de Medeiros, K.S.; Araújo-Filho, I. Robotic Surgery versus Conventional Laparoscopy in Colon Cancer Patients: A Systematic Review and Meta-Analysis. *ACTA Cirúrgica Bras.* **2024**, *39*, e397224.
230. Zou, J.; Zhu, H.; Tang, Y.; Huang, Y.; Chi, P.; Wang, X. Robotic versus Laparoscopic Surgery for Rectal Cancer: An Updated Systematic Review and Meta-Analysis of Randomized Controlled Trials. *BMC Surg.* **2025**, *25*, 86. [CrossRef]
231. Eltair, M.; Hajibandeh, S.; Hajibandeh, S.; Nuno, A.; Abdullah, K.H.; Alkaili-Alyamani, A.; Aslam, M.I.; Sinha, A.; Agarwal, T. Meta-Analysis and Trial Sequential Analysis of Robotic versus Laparoscopic Total Mesorectal Excision in Management of Rectal Cancer. *Int. J. Color. Dis.* **2020**, *35*, 1423–1438. [CrossRef]
232. Han, C.; Yan, P.; Jing, W.; Li, M.; Du, B.; Si, M.; Yang, J.; Yang, K.; Cai, H.; Guo, T. Clinical, Pathological, and Oncologic Outcomes of Robotic-Assisted versus Laparoscopic Proctectomy for Rectal Cancer: A Meta-Analysis of Randomized Controlled Studies. *Asian J. Surg.* **2020**, *43*, 880–890. [CrossRef]

233. Ryan, O.K.; Ryan, É.J.; Creavin, B.; Rausa, E.; Kelly, M.E.; Petrelli, F.; Bonitta, G.; Kennelly, R.; Hanly, A.; Martin, S.T.; et al. Surgical Approach for Rectal Cancer: A Network Meta-Analysis Comparing Open, Laparoscopic, Robotic and Transanal TME Approaches. *Eur. J. Surg. Oncol.* **2021**, *47*, 285–295. [CrossRef]
234. Yang, L.; Fang, C.; Bi, T.; Han, J.; Zhang, R.; Zhou, S. Efficacy of Robot-Assisted vs. Laparoscopy Surgery in the Treatment of Colorectal Cancer: A Systematic Review and Meta-Analysis. *Clin. Res. Hepatol. Gastroenterol.* **2023**, *47*, 102176. [CrossRef]
235. Asmat, M.L.V.; Caballero-Alvarado, J.; Lozano-Peralta, K.; Mariñas, H.V.; Zavaleta-Corvera, C. Robotic versus Laparoscopic Approaches for Rectal Cancer: A Systematic Review and Meta-Analysis of Postoperative Complications, Anastomotic Leak, and Mortality. *Langenbeck's Arch. Surg.* **2024**, *409*, 353. [CrossRef]
236. Zhu, L.; Li, X.; Zhang, H.; Li, H.; Shen, X. Urinary and Sexual Function after Robotic and Laparoscopic Rectal Cancer Surgery: A Systematic Review and Meta-Analysis. *J. Robot. Surg.* **2024**, *18*, 262. [CrossRef]
237. Ohtani, H.; Maeda, K.; Nomura, S.; Shinto, O. Meta-Analysis of Robot-Assisted Versus Laparoscopic Surgery for Rectal Cancer. *Vivo* **2018**, *32*, 611–623.
238. Milone, M.; Manigrasso, M.; Velotti, N.; Torino, S.; Vozza, A.; Sarnelli, G.; Aprea, G.; Maione, F.; Gennarelli, N.; Musella, M.; et al. Completeness of Total Mesorectum Excision of Laparoscopic versus Robotic Surgery: A Review with a Meta-Analysis. *Int. J. Color. Dis.* **2019**, *34*, 983–991. [CrossRef] [PubMed]
239. Zhu, Q.L.; Xu, X.; Pan, Z.J. Comparison of Clinical Efficacy of Robotic Right Colectomy and Laparoscopic Right Colectomy for Right Colon Tumor: A Systematic Review and Meta-Analysis. *Medicine* **2021**, *100*, e27002. [CrossRef] [PubMed]
240. Tang, X.; Wang, Z.; Wu, X.; Yang, M.; Wang, D. Robotic versus Laparoscopic Surgery for Rectal Cancer in Male Urogenital Function Preservation, a Meta-Analysis. *World J. Surg. Oncol.* **2018**, *16*, 196. [CrossRef]
241. Falola, A.F.; Adeyeye, A.; Shekoni, O.; Oluwagbemi, A.; Effiong-John, B.; Ogbodu, E.; Dada, O.S.; Ndong, A. Robotic and Laparoscopic Minimally Invasive Surgery for Colorectal Cancer in Africa: An Outcome Comparison Endorsed by the Nigerian Society for Colorectal Disorders. *Surg. Endosc.* **2025**, *39*, 122–140. [CrossRef] [PubMed]
242. Ricciardi, R.; Seshadri-Kreaden, U.; Yankovsky, A.; Dahl, D.; Auchincloss, H.; Patel, N.M.; Hebert, A.E.; Wright, V. The COMPARE Study: Comparing Perioperative Outcomes of Oncologic Minimally Invasive Laparoscopic, Da Vinci Robotic, and Open Procedures: A Systematic Review and Meta-Analysis of the Evidence. *Ann. Surg.* **2025**, *281*, 748–763. [CrossRef] [PubMed]
243. de'Angelis, N.; Schena, C.A.; Azzolina, D.; Carra, M.C.; Khan, J.; Gronnier, C.; Gaujoux, S.; Bianchi, P.P.; Spinelli, A.; Rouanet, P.; et al. Histopathological Outcomes of Transanal, Robotic, Open, and Laparoscopic Surgery for Rectal Cancer Resection. A Bayesian Network Meta-Analysis of Randomized Controlled Trials. *Eur. J. Surg. Oncol.* **2025**, *51*, 109481. [CrossRef]
244. Huang, Y.-J.; Kang, Y.-N.; Huang, Y.-M.; Wu, A.T.; Wang, W.; Wei, P.-L. Effects of Laparoscopic vs Robotic-Assisted Mesorectal Excision for Rectal Cancer: An Update Systematic Review and Meta-Analysis of Randomized Controlled Trials. *Asian J. Surg.* **2019**, *42*, 657–666. [CrossRef]
245. Thrikandiyur, A.; Kourounis, G.; Tingle, S.; Thambi, P. Robotic versus Laparoscopic Surgery for Colorectal Disease: A Systematic Review, Meta-Analysis and Meta-Regression of Randomised Controlled Trials. *Ann. R. Coll. Surg. Engl.* **2024**, *106*, 658–671. [CrossRef]
246. Slim, K.; Tilmans, G.; Occéan, B.V.; Dziri, C.; Pereira, B.; Canis, M. Meta-Analysis of Randomized Clinical Trials Comparing Robotic versus Laparoscopic Surgery for Mid-Low Rectal Cancers. *J. Visc. Surg.* **2024**, *161*, 76–89. [CrossRef]
247. Yang, H.; Zhou, L. The Urinary and Sexual Outcomes of Robot-Assisted versus Laparoscopic Rectal Cancer Surgery: A Systematic Review and Meta-Analysis. *Surg. Today* **2024**, *54*, 397–406. [CrossRef]
248. Phan, K.; Kahlaee, H.R.; Kim, S.H.; Toh, J.W.T. Laparoscopic vs. Robotic Rectal Cancer Surgery and the Effect on Conversion Rates: A Meta-Analysis of Randomized Controlled Trials and Propensity-Score-Matched Studies. *Tech. Coloproctol.* **2019**, *23*, 221–230. [CrossRef]
249. Stylianidi, M.C.; Vaghiri, S.; Knoefel, W.T.; Prassas, D. Current Evidence of Single-Port Laparoscopic versus Single Port-Robotic Techniques in Colorectal Surgery: A Meta-Analysis. *Chirurgia* **2024**, *119*, 471. [CrossRef] [PubMed]
250. Liao, B.; Xue, X.; Zeng, H.; Ye, W.; Xie, T.; Wang, X.; Lin, S. Comparison of Different Surgical Techniques and Anastomosis Methods in Short-Term Outcomes of Right Colon Cancer: A Network Meta-Analysis of Open Surgery, Laparoscopic, and Robot-Assisted Techniques with Extracorporeal and Intracorporeal Anastomosis. *Updates Surg.* **2025**, *77*, 309–325. [CrossRef] [PubMed]
251. Bao, X.; Wang, H.; Song, W.; Chen, Y.; Luo, Y. Meta-Analysis on Current Status, Efficacy, and Safety of Laparoscopic and Robotic Ventral Mesh Rectopexy for Rectal Prolapse Treatment: Can Robotic Surgery Become the Gold Standard? *Int. J. Color. Dis.* **2021**, *36*, 1685–1694. [CrossRef]
252. Liu, C.; Li, X.; Wang, Q. Postoperative Complications Observed with Robotic versus Laparoscopic Surgery for the Treatment of Rectal Cancer: An Updated Meta-Analysis of Recently Published Studies. *Medicine* **2021**, *100*, e27158. [CrossRef] [PubMed]
253. Zhu, X.-M.; Bai, X.; Wang, H.-Q.; Dai, D.-Q. Comparison of Efficacy and Safety between Robotic-Assisted versus Laparoscopic Surgery for Locally Advanced Mid-Low Rectal Cancer Following Neoadjuvant Chemoradiotherapy: A Systematic Review and Meta-Analysis. *Int. J. Surg.* **2025**, *111*, 1154–1166. [CrossRef] [PubMed]

254. Wang, W.; Li, S.; Liu, X. Comparative Analysis of the Safety and Effectiveness of Robotic Natural Orifice Specimen Extraction versus Laparoscopic Surgery for Colorectal Tumors through Systematic Review and Meta-Analysis. *J. Robot. Surg.* **2024**, *18*, 374. [CrossRef]
255. Puntambekar, S.; Bharambe, S.; Pawar, S.; Chitale, M.; Panse, M. Feasibility of Transthoracic Esophagectomy with a Next-Generation Surgical Robot. *Sci. Rep.* **2022**, *12*, 17925. [CrossRef]
256. Bindal, V.; Sethi, D.; Pandey, D. Robotic Primary Bariatric Surgery. *Dig. Med. Res.* **2021**, *4*, 56. [CrossRef]
257. Sun, M.; Li, W.; Zhang, C.; Li, S.; Zhou, F.; Zhu, Y.; Zhou, X. Da Vinci Xi^{TM} Robot-Assisted Liver Resection. *Intell. Surg.* **2022**, *1*, 16–20. [CrossRef]
258. Choi, Y.J.; Sang, N.T.; Jo, H.-S.; Kim, D.-S.; Yu, Y.-D. A Single-Center Experience of over 300 Cases of Single-Incision Robotic Cholecystectomy Comparing the Da Vinci SP with the Si/Xi Systems. *Sci. Rep.* **2023**, *13*, 9482. [CrossRef]
259. Takagi, K.; Umeda, Y.; Yoshida, R.; Fuji, T.; Yasui, K.; Kimura, J.; Hata, N.; Mishima, K.; Yagi, T.; Fujiwara, T. Surgical Strategies to Dissect around the Superior Mesenteric Artery in Robotic Pancreatoduodenectomy. *J. Clin. Med.* **2022**, *11*, 7112. [CrossRef]
260. Erozkan, K.; Gorgun, E. Development of Robotic Surgical Devices and Its Application in Colorectal Surgery. *Mini-Invasive Surg.* **2023**, *7*, 37. [CrossRef]