Результати роботизованої правосторонньої колектомії з внутрішньокорпоральним анастомозом і лапароскопічної правосторонньої колектомії

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Outcomes of robotic right colectomy with intracorporeal anastomosis compared with laparoscopic right colectomy

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Introduction

Colorectal cancer represents a very common condition, especially in developed regions [1, 2]. Despite recent technical and technological advancements, the anastomotic leak still represents one of the most feared complications in colorectal cancer surgery, reaching a 15% postoperative mortality [3], delaying subsequent oncological treatments and causing worse overall disease-free survival [4, 5] as well as higher rates of local recurrence and cancer-related long-term mortality [6]. However, there is no universally accepted definition of anastomotic leak [7, 8] and surgeons show significant heterogeneity in what they define as an anastomotic leak [9]. Anastomotic leak rates vary between 1 and 30%, although in experienced colorectal units, it might be lower (3–6%) [10], depending on the definition, the tumour site, the surgical techniques used, or the individual surgeon performing surgery [11–13]. Several risk factors have been identified for anastomotic leak, including age, preoperative nutritional status, or laparoscopic approach [14]. Stapled anastomosis has been reported to present higher rates of clinically relevant anastomotic leak, but without increasing either mortality or length of stay [14, 15].

Since the first report of laparoscopic surgery for colorectal cancer in 1991 [16], its popularity has been increasing worldwide based on evidence that laparoscopic surgery provides better short-term outcomes and similar oncological outcomes compared with open surgery [17–20]. Laparoscopic right hemicolectomy is one of the most common procedures in colorectal cancer surgery, which is employed for right-sided colon cancer. However, it has several unique issues, unlike other colorectal cancer surgeries. There were several different approaches for lymph node dissection (i.e. medial-to-lateral, lateral-to-medial, and cranial-to-caudal) and reconstruction (i.e. intracorporeal and extracorporeal). Furthermore, there are anatomical variations in vascular structures encountered during laparoscopic right hemicolectomy, and various landmarks have been proposed for a successful surgery. The optimal extent of lymphadenectomy is also being discussed. In

fact, open surgery is still preferred and performed in a considerable number of cases despite the strong evidence demonstrating the superiority of laparoscopic surgery in terms of short-term outcomes [21]. However, in recent years, the utilization of the robotic approach has been reported as an alternative to laparoscopic right hemicolectomy.

Further, the advantages associated with laparoscopic right colectomy are earlier return to normal bowel function, shorter length of hospital stay, fewer wound complications, and similar oncological outcomes as can be achieved through the conventional open approach [22]. Construction of the ileocolic anastomosis can be accomplished with an extracorporeal or intracorporeal technique. However, intracorporeal anastomosis (IA) has not yet become the standard of care for minimally invasive surgery, primarily because it is more technically challenging. Consequently, extracorporeal anastomosis (EA) continues to be more widely adopted [23]. Nevertheless, there is an increasing body of literature describing the benefits of IA in the right hemicolectomy, namely the ability to mobilize the bowel under vision without extending traction on the mesentery [24, 25]. Potential intraoperative benefits of the IA technique include less mobilization—especially in patients with high body mass index, reduced manipulation of bowel, smaller incisions, and freedom to choose the extraction site [25–28]. Whereas the EA extraction incision is midline; the IA extraction incision can be placed off the midline in a transverse, paramedian, or oblique position and potentially lower the risk of incisional hernia [25–29]. Postoperative benefits include reduced narcotic use, faster time to flatus, shorter length of hospital stay, and reduced hernia rates [25, 26, 29, 30].

Robotic-assisted right colectomy with intracorporeal anastomosis (RIA) is a relatively new means to overcome some of the technical challenges of the laparoscopic approach, and early studies have reported its feasibility and safety improved early postoperative outcomes and similar rates of anastomotic leak [30, 31]. In a meta-analysis of trials comparing robotic right colectomy with laparoscopic right colectomy—both with

intracorporeal and extracorporeal anastomotic techniques—Petruciani et al. reported the feasibility and safety of robotic right colectomy but the lack of significant differences in short term outcomes, complications, or conversion rates [32].

Furthermore, based on the annual report of the Japanese National Clinical Database, right hemicolectomy has been more widely and frequently performed by non-board-certified surgeons in gastroenterology compared with low anterior resection [33]. However, the 30-day mortality rate is consistently higher in right hemicolectomy than low anterior resection. According to the Japanese National Clinical Database, the rate of laparoscopic surgery in the right hemicolectomy is also markedly lower than that in low anterior resection [34]. These findings revealed that there are some clinical problems to be analyzed or discussed on laparoscopic right hemicolectomy. Thus, its applicability, techniques, and trend are chaotic, although laparoscopic right hemicolectomy is popular and widespread as one of the standard surgical treatments for right-sided colon cancer. With this scenario, the present review article was conducted with a primary aim to elucidate the outcomes after robotic-assisted right colectomy with intracorporeal anastomosis compared to laparoscopic right colectomy and current perspectives on these techniques.

Laparoscopic vs robotic approach

In contrast, the usefulness of laparoscopic vs robotic right hemicolectomy is still uncertain, although a growing number of comparative studies on that topic have been published in recent years [30, 35–40]. The first comparative study of the outcome of laparoscopic vs robotic right hemicolectomy was reported by Rawlings et al. In their retrospective study, the total operative time was significantly ($p=0.002$) longer in the robotic surgery group ($n=17$) than the laparoscopic surgery group ($n=15$) (218.9 min vs 169.2 min). The robotic surgery group demonstrated a significant increase in total operating room cost, operating room personnel cost, operating room supply cost, and operating room time cost [41]. The first randomized control trial of robotic vs laparoscopic right colectomy was reported by Park et al. In their study, hospital stay, operative complications, postoperative pain score, resection margin clearance, and a number of harvested lymph nodes were similar in both groups. The operative time was longer, and the overall hospital cost was higher in the robotic group (195 min vs 130 min; $p<0.001$; and USD, \$12,235 vs \$10,320; $p=0.013$, respectively). They concluded that robotic right colectomy provided no benefit to justify the greater cost [42]. Recent review by Solaini et al. demonstrated similar outcomes, such as longer operative time and higher hospital cost in robotic surgery [39]. However, the most recent meta-analysis compared open surgery, laparoscopic-assisted surgery, total laparoscopic surgery (with intracorporeal anastomosis), and robotic right hemicolectomy to assess the short-term outcomes. Based on their analysis, the overall complication rate was similar between robotic and total laparoscopic surgery but higher in open and laparoscopic-assisted surgery than robotic surgery. The operative time was similar between

robotic and total laparoscopic surgery, and hospital stay was significantly longer in laparoscopic-assisted surgery than in robotic surgery. Their meta-analysis revealed that the short-term outcomes following robotic and total laparoscopic right hemicolectomy were superior to standard laparoscopic and open surgeries [43]. Nevertheless, the use of a robotic approach for right hemicolectomy is still argued about due to its association with longer operative times and greater hospital cost with the limited advantage of its use. Therefore, laparoscopy is currently the most commonly utilized approach in the right hemicolectomy.

Intra- versus extracorporeal ileocolic anastomosis after right colectomy

Many studies have been published to identify the best anastomotic technique after right colectomy, usually focusing on an anastomotic leak, surgical complication rates, or the need for reoperation. On this line, recent meta-analyses report different advantages for IA, such as shorter laparotomy incisions, shorter time to first flatus and bowel movement, shorter length of stay or a lower incisional hernia rate [44–47]. One meta-analysis, with more than 4000 patients included [46] reported lower rates of anastomotic leak in IA. In contrast, others did not show any differences between IA and EA [44, 46, 47]. Similar to these findings reported in the literature, the results of Vallribera et al. are similar without significant differences neither for global surgical complications, surgical site infection, anastomotic leak, nor the need for reoperation. In addition, similar to the previously mentioned studies, Vallribera et al. found no surgical wound complications in the IA group compared with four patients in the EA group [48].

A multivariate analysis conducted by Vallribera et al. revealed that EA was an independent risk factor for surgical complications [48]. These results are similar to the findings published by Shapiro et al. in a comparative study of 191 patients, in which IA was associated with fewer overall postoperative complications, decreased rates of SSI, and fewer Clavien–Dindo III complications [25]. The other risk factors for surgical complications reported in the multivariate analysis study of Vallribera et al. were the need for blood transfusions. Neither drainage left at surgery, physiological POSSUM score, nor ASA score were risk factors for surgical complications [48].

An interesting aspect is the analysis of medical complications. Patients in the EA group presented higher global morbidity and more medical complications. EA remained an independent risk factor for overall complications in the multivariate analysis study of Vallribera et al., as well as a higher POSSUM score. The most common medical complication reported is related to postoperative anaemia (9.2% vs. 1% in EA and IA, respectively), which could be related to higher blood loss during surgery. It might be hypothesized that the greater mesenteric traction to perform an EA might contribute to a greater risk of bleeding [48]. These results could be explained by the results published by Wu et al., which described reduced blood loss in IA [47]. This could be an interesting variable to consider in further studies, provided that it is adequately assessed and recorded.

Robotic right colectomy with intracorporeal anastomosis

Most surgeons performing laparoscopic right colectomy use the EA approach. In comparison, IA is considered more technically challenging and difficult in terms of laparoscopic suturing [14]. However, robotic-assisted IA during right colectomy is gaining interest among experienced colorectal surgeons, several of whom have reported their experiences [10, 11, 13, 15, 49]. This renewed interest in IA seems to correlate with the increased use of robotics in colorectal resections.

Lujan et al. delineated that the advantages of RIA were less blood loss, shorter incision lengths, and longer specimen lengths. Operative times were significantly longer in the robotic cohort. Furthermore, these findings were in accordance with various other researchers reported in the literature [8, 44–47, 50]. The robotic technique is relatively new and continuously undergoes rapid advancements and refinements as the robotic technology changes (Si to Xi, vessel sealer, Endowrist stapler, etc.) These advancements will likely impact efficiencies and operative times. Lujan et al. also reported that longer specimen lengths could be achieved due to the totally intracorporeal resection of the specimen. Longer specimen length likely accounts for the higher lymph node yield in the RIA group compared with that achieved in the LEA group. More consistent and standardized resection can be realized with the RIA technique. For example, proximal and distal margins are clearly visualized and do not depend on the extent of dissection or mobilization, abdominal wall thickness, or the lack of adequate exposure through a small extraction site, as is true with the EA technique [51]. Lujan et al. reported smaller extraction site incisions could be achieved with IA than can be achieved with EA, as has been reported in the literature [8, 52]. Lujan et al. delineated that the RIA group also trended toward lower rates of conversion (2.25% vs. 6.7%) [51]. These findings of low conversion rate were similar to that reported by Aiolfi et al. in a group of patients who underwent RIA for malignant disease (n=50, conversion=0.0%) [44]. Moreover, von Elm et

al. in their recent systematic review and meta-analysis, analyzed the literature describing intraoperative and postoperative results after robotic and laparoscopic right colectomy: the weighted rate of conversion to open surgery was lower (although it did not reach statistical significance) for the robotic cases (4.3%) than for the laparoscopic patients (7.1%) [53].

The robotic group experienced lower rates of readmissions, postoperative complications, and incisional hernias than the LEA group—although these differences were not statistically significant. The tendency toward lower rates of postoperative complications and mortality indicates the safety and efficacy of the robotic-assisted procedure [51].

Some authors have suggested that the robot may facilitate difficult or complex tasks during a procedure such as splenic flexure mobilization, pelvic dissection, and construction of an anastomosis [54–57]. However, Lujan et al. believe that the intuitive nature of the robot and the improved surgical dexterity facilitate the transition from an extracorporeal anastomosis technique to an intracorporeal anastomosis [58]. In fact, some studies have suggested that intracorporeal anastomosis results in superior postoperative outcomes and possibly lower extraction-site morbidity such as hernia and wound infection [26, 56, 59, 60]. For example, there is probably less trauma, traction, and tension applied to the ileum, colon, and mesentery during an intracorporeal anastomosis technique. After intracorporeal transection, the terminal ileum and transverse colon almost always reach without tension for anastomosis. Because the specimen is completely detached, it can be brought out through any extraction site. Less mobilization of the transverse colon is necessary because it does not have to reach the abdominal wall for anastomosis as with extracorporeal anastomosis and can simply lie in its normal anatomic position after transection. Conversely, when the extracorporeal anastomosis is performed, trauma and stretching of the bowels and their mesentery can occur during externalization. On the other hand, the creation of an extracorporeal anastomosis is often partially blind, especially in obese patient

Clinical outcomes between intracorporeal and extracorporeal anastomosis

Study Type	Term	Sample Size		Surgery	Clinical Outcomes	References
		IA	EA			
Retrospective cohort	Shortterm	67	97	Right colectomy	Shorter length of hospital stay and more incisional surgical site infections.	Widmar et al., 2020 [63]
Meta-analysis	Shortterm	2123	2327	Right colectomy	Decreased extraction site incisions, earlier bowel recovery, and fewer complications and rate of conversion.	Emile et al., 2019 [45]
Retrospective description	Shortterm	21	-	Right colectomy	Feasible, safe, efficacious, and oncologically acceptable	Kelley et al., 2018 [64]
Retrospective study	Shortterm	52	-	Right colectomy	Safe and feasible	Lujan et al., 2015 [58]
Retrospective description	Longterm	162	-	Transverse colectomy	Safe and feasible	Jung et al., 2015 ⁶⁵
Retrospective cohort	Shortterm	57	57	Sigmoidectomy	Fewer conversion, extraction site hernias, and longer operative time	Al Natour et al., 2019 [66]

[56, 61, 62]. These differences may translate into less postoperative ileus and fewer complications. In theory, this could favourably impact the length of stay and anastomotic leak rates.

Another advantage of the intracorporeal anastomosis technique (which demands the total intracorporeal resection of the specimen) is that it allows the surgeon to choose where to place the incision for extraction. Recent data have shown that keeping the extraction site off the midline results in decreased risk of hernia. Samia et al. showed an almost two-fold increase in the risk of incisional hernia when the extraction site was placed in the midline. By using an intracorporeal anastomosis technique, the surgeon can choose an extraction site off the midline [29]. Studies of clinical outcomes between intracorporeal and extracorporeal anastomosis are listed in *Table*.

Robotic right colectomy with intracorporeal anastomosis – technical variants

From the early nineties, conventional direct manual laparoscopy had a rapid growth in several surgical scenarios, and nowadays, it is considered a cornerstone in colorectal surgery [67]. The robotic approach, with its technological advantages, makes some surgical manoeuvres easier. In particular, thanks to these aspects and to the introduction of robotic staplers, there is a growing interest and expansion of robotic assistance during right colectomy due to the facilitating effect that could have an impact in the reconstructive phase, contributing to the greater adoption of intracorporeal anastomosis also from less experienced surgeons.

Robotic intracorporeal anastomosis during right colectomy is a safe procedure. According to several technical variants, it can be accomplished either regarding the type of stapler used, the type of enterocolotomy closure technique, or it can be performed totally hand sewn. According to a systematic review and meta-analysis study conducted by Guadagni et al. revealed that there is no evidence of the superiority of any of these surgical techniques with respect to another. The side-to-side isoperistaltic anastomosis, realized with laparoscopic staplers and double-layer closure for enterocolotomy, is the most commonly used technique. There could be a reduction in bleeding rate with the use of robotic staplers, likely related to the technological innovations brought by the smart clamp® technology. Given the widespread of robotic surgery and the possible impact it may have on the diffusion of intracorporeal anastomosis during right colectomy [68]. However, further randomized controlled studies are necessary to clarify whether a superiority may exist among one of these technical variants.

Conclusions

For right colectomy, robotic surgery is feasible and as safe as laparoscopic surgery. Clinical outcomes for robotic-assisted right colectomy with intracorporeal anastomosis are comparable to those for laparoscopic right colectomy with intracorporeal anastomosis. The intracorporeal anastomosis can be performed safely with the robotic approach. Furthermore, the surgeon's comfort with intracorporeal anastomosis was achieved only with the robotic approach.

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