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Intracorporeal vs. extracorporeal anastomosis preference for minimally invasive right hemicolectomy: A combined SAGES and EAES survey

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Abstract

Introduction Intracorporeal anastomosis (ICA) for minimally invasive (MIS) right hemicolectomy is associated with lower rates of postoperative ileus, pain, and future ventral incisional hernia when compared to extracorporeal anastomosis (ECA). However, the rate of adoption of ICA has been slow. This may be attributed to the advanced minimally invasive intracorporeal suturing technical skills required for ICA. A survey was distributed among SAGES and EAES members to assess the current level of adoption of ICA into clinical practice.

Methods An anonymous 13 question survey was distributed to SAGES and EAES members in 2023–2024 via email, SAGES Facebook, and SAGES Twitter/X. Response inclusion criteria included performing at least 20 minimally invasive segmental colectomies annually. Questions included year of surgical training completion, ICA vs. ECA preference with rationale, and ICA type of training and/or mentorship. A Chi-square test was used to compare the association between decade of training completion and use of ICA vs ECA.

Results 902 respondents participated and 796 performed at least 20 minimally invasive segmental colectomies per year. 457 (57%) were currently performing ICA for right hemicolectomies in over 80% of cases. Of these 457 respondents, over half reported several benefits when performing ICA vs ECA including less subjective pain (281, 64%) and lower rate of surgical site infections (274, 63%). When asked about the biggest hurdle to performing ICA, the 339 (43%) ECA preferred respondents selected added time and/or cost in the OR. There was no statistically significant association between the decade of training and choice of surgical technique ($p = 0.829$).

Discussion Adoption of ICA for minimally invasive right hemicolectomy is on the rise in this predominantly advanced MIS group of surgeons, as it is routinely performed by over half of the SAGES and EAES membership. Operative time, cost, and additional training and mentorship are the barriers for wider adoption.

Keywords Anastomosis · Extracorporeal · Intracorporeal · Colectomy · Robotics · Surgery

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Intracorporeal anastomosis (ICA) for minimally invasive (MIS) right hemicolectomy with off-midline specimen

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extraction site has resulted in lower rates of postoperative ileus, pain, and future ventral incisional hernias when compared to extracorporeal anastomosis (ECA) [1–10]. Unlike ICA, Extracorporeal Anastomosis (ECA) is typically performed with peri-umbilical or midline extraction sites, which contribute to increased pain and the likelihood of future ventral incisional hernias [11]. However, intracorporeal anastomosis requires more advanced minimally invasive intracorporeal suturing technical skills, which may contribute to its slow rate of surgical adoption over the last ten years.

One of the drivers of expanding the adoption of ICA is the rapid uptake of robotic minimally invasive techniques in colon resections, with an increased preference for ICA among robotic minimally invasive right hemicolectomy [10]. This has led to difficulty with data accrual comparing ICA to ECA, as many robotic surgeons do not feel comfortable performing ECA leading to difficulty with patient enrollment and observational rather than randomized clinical trials, such as the Minimally Invasive Right Colectomy Anastomosis Study (MIRCAST), which recently published early data that demonstrated no difference in outcomes in surgical site infections and severe postoperative complications between ICA and ECA [12].

In order to gauge the level of adoption of ICA into clinical practice among high-volume minimally invasive surgeons routinely performing minimally invasive right hemicolectomy and to investigate the barriers and enablers for adoption of ICA, a survey was drafted and distributed among the Society of American Gastrointestinal and Endoscopic Surgeons (SAGES) and the European Association of Endoscopic Surgery (EAES) membership and social media platforms in 2023 and 2024. We hypothesized that the rate of ICA adoption was still in the early adoption phase, and ECA would be reported as the majority of current practice for minimally invasive right hemicolectomy.

Methods

The study survey was developed by members of the SAGES Colorectal Surgery (CRS) Committee to assess anastomosis preference among high-volume minimally invasive surgeons routinely performing right hemicolectomy. The drive for this project was to guide the type of hands-on courses offered during the 2024 SAGES Annual Scientific Meeting, based on the outcome of this survey. High-volume minimally invasive surgeons were defined as surgeons who performed at least 20 minimally invasive segmental colectomies annually. Participants included clinicians contacted via the SAGES email list serve, EAES email list serve, SAGES Facebook page, SAGES X account, and SAGES CRS Committee members. All survey questions were the same; however,

each group survey tag was different to allow for comparison among the responding groups. The responses were anonymous as they did not require specific surgeon identifying information.

The survey was initially distributed to SAGES CRS Committee members by email and via social media on May 23, 2023. On June 5th, 2023, the survey was sent via email to SAGES and EAES members by email. Two reminder emails were sent for both SAGES and EAES member emails. On May 9, 2024, the survey was closed. The data were collected using Google Sheets and analyzed on Microsoft Excel. We performed a Chi-Square analysis to compare year of training versus preference for performing ICA.

The first question solicited the number of minimally invasive segmental colectomies performed annually. Only respondents who performed 20 or more minimally invasive segmental colectomies were allowed to proceed to the subsequent survey questions. The survey concluded for those respondents answering less than 20 minimally invasive segmental colectomies annually. The remaining 12 questions of the survey divided participants into two cohorts depending on whether they performed ICA for right hemicolectomy greater than 80% of the time vs. ECA for right hemicolectomy. If the participant did perform ICA greater than 80% of the time, follow-up questions elicited information on year of completion of training, how ICA was learned, when ICA was incorporated into practice, the perceived benefits of using ICA compared to ECA, and views on complications and complications rates of ICA compared to their prior ECA practice. If ICA was used less than 80% of the time, the survey collected information on year of completion of training, the biggest hurdles to performing ICA, and what would be needed for the respondent to start performing ICA (Fig. 1). Descriptive data were presented and a Chi-square test was used to compare the association between survey responses and use of ICA vs ECA.

Results

A total of 902 respondents participated in the survey via one of the five survey collection tools: (1) SAGES Email, (2) EAES email, (3) SAGES Facebook, (4) SAGES Twitter/X, and (5) SAGES CRS Committee. The majority of respondents were captured by email (Table 1). Of the 902 original respondents, 796 performed at least 20 laparoscopic or robotic segmental colectomies per year and continued on with the survey (Fig. 1), while 106 participants either answered no or chose to not continue the survey. The remaining 796 participants were divided into either an ICA or ECA cohort depending on whether they routinely performed ICA for right hemicolectomies (Fig. 1).

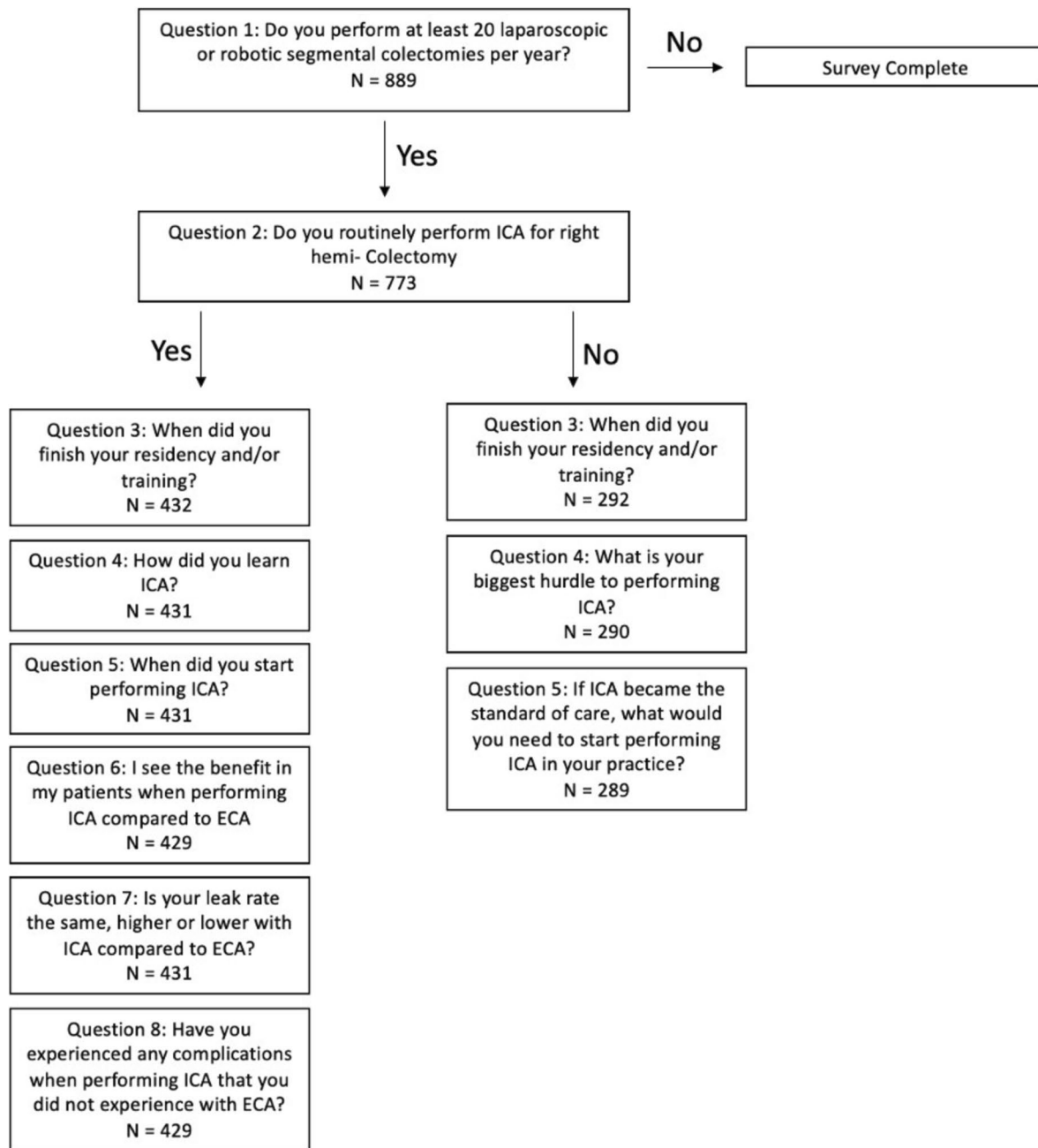


Fig. 1 ICA vs. ECA survey question flow chart

ICA cohort – Table 1

The results of the survey for respondents who answered ‘Yes’ to routinely performing ICA for right hemicolectomy are listed in Table 1. The survey first collected information on surgeon year of training completion, how they learned ICA, and when they started performing the technique. Then, the latter half of the survey examined participant views on the technique. Most participants saw several benefits of performing ICA compared to ECA such as less pain, lower rate

of SSIs, and earlier return of bowel function, and half of the participants noted a similar leak rate between ECA and ICA. Lastly, the majority of participants did not experience any new complications with ICA that they did not experience with ECA (Table 1). These findings.

ECA cohort – Table 2

The results of the respondents who answered ‘No’ to routinely performing ICA for right hemicolectomy are listed

Table 1 Responses from participants who routinely perform ICA for right hemicolectomy

Question	All	SAGES Email	EAES Email	SAGES Masters CRS Facebook	SAGES Twitter/X	SAGES CRS Commit- tee
<i>Question 3: When did you finish your residency and/or fellowship training?</i>						
Prior to 1990	25 (6%)	7 (6%)	18 (8%)	0	0	0
1991 – 2000	83 (19%)	22 (18%)	50 (22%)	4 (10%)	6 (38%)	1 (3%)
2001 – 2010	112 (26%)	27 (22%)	65 (28%)	8 (23)	1 (6%)	11 (32%)
2011 – 2020	164 (37%)	48 (39%)	69 (30%)	22 (59%)	9 (56%)	16 (47%)
2021 – Present	54 (12%)	18 (15%)	27 (12%)	3 (8%)	0	6 (18%)
Total	438	122	229	37	16	34
<i>Question 4: How did you learn ICA? Select all that apply</i>						
Surgical training (residency/fellowship)	167 (38%)	54 (44%)	86 (38%)	10 (27%)	5 (31%)	12 (35%)
Postgraduate course	75 (17%)	21 (17%)	41 (18%)	4 (11%)	3 (19%)	6 (18%)
A colleague/partner in person trained me	72 (16%)	11 (9%)	51 (22%)	6 (16%)	1 (6%)	3 (9%)
A colleague/partner mentored me intraoperatively	96 (22%)	22 (18%)	63 (28%)	7 (19%)	2 (13%)	4 (12%)
Independent learning*	204 (47%)	61 (50%)	83 (36%)	29 (78%)	12 (75%)	19 (56%)
Other	28 (6%)	8 (7%)	12 (5%)	5 (14%)	0	3 (9%)
Total	437	122	228	37	16	34
<i>Question 5: When did you start performing ICA?</i>						
Before 2010	66 (15%)	16 (13%)	42 (18%)	2 (5%)	5 (31%)	1 (3%)
2011 – 2014	78 (18%)	17 (14%)	50 (22%)	1 (3%)	3 (19%)	7 (21%)
2015 – 2019	161 (37%)	49 (40%)	72 (32%)	20 (54%)	5 (31%)	15 (44%)
2020 – Present	132 (30%)	40 (33%)	64 (28%)	14 (38%)	3 (19%)	11 (32%)
Total	437	122	228	37	16	34
<i>Question 6: I see the benefit in my patients when performing ICA compared to ECA (select all that apply)</i>						
Less subjective pain reporting	281 (65%)	88 (73%)	122 (54%)	26 (70%)	15 (94%)	30 (88%)
Lower rate of SSI's	274 (63%)	67 (55%)	153 (67%)	20 (54%)	12 (75%)	22 (65%)
Earlier tolerance of oral intake	215 (49%)	65 (54%)	95 (42%)	23 (62%)	11 (69%)	21 (62%)
Earlier return of bowel function	280 (64%)	76 (63%)	141 (62%)	27 (73%)	13 (81%)	23 (68%)
I do not see a difference compared to ECA	43 (10%)	16 (13%)	20 (9%)	4 (11%)	0	3 (9%)
Total	435	121	227	37	16	34
<i>Question 7: Is your leak rate the same, higher, or lower with ICA compared to ECA?</i>						
Same	224 (51%)	63 (51%)	118 (52%)	17 (46%)	4 (25%)	22 (65%)
Higher	5 (1%)	1 (1%)	4 (2%)	0	0	0
Lower	132 (30%)	38 (31%)	73 (31%)	8 (22%)	8 (50%)	5 (15%)
Unknown	76 (17%)	20 (16%)	33 (14%)	12 (32%)	4 (25%)	7 (21%)
Total	437	122	288	37	16	34
<i>Question 8: Have you experienced any complications when performing ICA that you did not experience with ECA?</i>						
Yes	59 (14%)	11 (9%)	37 (16%)	7 (19%)	1 (6%)	3 (9%)
No	376 (86%)	110 (91%)	190 (84%)	30 (81%)	15 (94%)	31 (91%)
Total	435	121	227	37	16	34

*Independent learning included social media, surgical society videos, and online mentoring

in Table 2. Of the 339 (43%) participants who selected 'No' to the question asking if they routinely performed ICA for right hemicolectomies, 294 completed the remaining survey questions. First, demographic information regarding completion of residency was collected via the survey. The survey then examined the biggest obstacles

for surgeons to perform ICA. The majority selected added time or cost, concern for increase complications, and lack of evidence. Additionally, if ICA became standard of care, respondents said they would need a randomized control trial comparing ECA to ICA before they would start performing ICA in their practice.

Table 2 Responses from participants who perform ECA for right hemicolectomy

Question	All	SAGES Email	EAES Email	SAGES Masters CRS Facebook	SAGES Twitter/X	SAGES CRS Commit- tee
<i>Question 3: When did you finish your residency and/or fellowship training?</i>						
Prior to 1990	20 (7%)	7 (10%)	11 (6%)	1 (8%)	1 (11%)	0
1991 – 2000	55 (19%)	13 (18%)	41 (22%)	0	1 (11%)	0
2001 – 2010	84 (29%)	20 (28%)	60 (30%)	2 (17%)	1 (11%)	1 (25%)
2011 – 2020	102 (35%)	24 (33%)	66 (34%)	7 (58%)	3 (33%)	2 (50%)
2021 – Present	33 (11%)	8 (11%)	19 (10%)	2 (17%)	3 (33%)	1 (25%)
Total	294	72	197	12	9	4
<i>Question 4: What is your biggest hurdle to performing ICA? (Select all that apply)</i>						
Added time and/or cost in the OR	139 (48%)	40 (55%)	87 (45%)	7 (58%)	4 (44%)	1 (25%)
No time for additional training to change technique	23 (8%)	4 (5%)	16 (8%)	1 (8%)	1 (11%)	1 (25%)
No money for additional training	12 (4%)	2 (3%)	10 (5%)	0	0	0
Concern for increased complications with ICA	92 (32%)	20 (27%)	64 (33%)	4 (33%)	3 (33%)	1 (25%)
I am not comfortable suturing laparoscopically	40 (14%)	8 (11%)	29 (15%)	2 (17%)	1 (11%)	0
The evidence for ICA has not convinced me	122 (42%)	28 (38%)	85 (44%)	4 (33%)	3 (33%)	2 (50%)
Other	33 (11%)	8 (11%)	22 (11%)	0	2 (22%)	1 (25%)
Total	292	73	194	12	9	4
<i>Question 5: If ICA became the standard of care, what would you need to start performing ICA in your practice?</i>						
RCT comparing ECA to ICA	150 (52%)	39 (53%)	98 (51%)	4 (33%)	7 (88%)	1 (25%)
Time/funding for ICA hands-on course & mentoring	80 (27%)	21 (29%)	52 (27%)	4 (33%)	2 (25%)	2 (50%)
Institutional mandate, training and mentorship	79 (27%)	15 (20%)	60 (31%)	3 (25%)	1 (13%)	0
Other	43 (15%)	11 (15%)	27 (14%)	3 (25%)	0	2 (50%)
	281	73	194	12	8	4

Table 3 No detectable distribution of preferred surgical technique (ICA vs ECA) among surgeons by training decade ($p=0.829$)

Decade training was complete	ICA	ECA
Prior to 1990	25 (6%)	20 (7%)
1991–2000	83 (19%)	55 (19%)
2001–2010	112 (26%)	84 (29%)
2010–2020	164 (37%)	102 (35%)
2021–Present	54 (12%)	33 (11%)
Total	438	294

*There was no statistically significant association between the decade of training and the choice of surgical technique among surgeons taking the survey

Training year for ICA vs ECA respondents

The distribution of preferred surgical technique (ICA vs ECA) among surgeons was plotted by the decade their training was complete in Table 3. A Chi-Square test was used to assess association between decade of training and use of ICA vs ECA. No statistically significant association was found ($p=0.829$) (Table 3).

Technical considerations

In order to address the respondents' concerns, we have created a surgical video that stratifies an intracorporeal anastomosis following a right colectomy into antiperistaltic and isoperistaltic techniques. This approach allows for a stratified stepwise method in creating these anastomoses, optimizing for ergonomics and minimizing the risk of complications, such as anastomotic leak.

After the resection has been performed and perfusion confirmed, we begin by aligning our anastomosis according to the orientation required. With an antiperistaltic approach, we place a suture using a 3–0 Vicryl stitch cut to 20 cm at the furthestmost aspect of the anastomosis with a second suture at the proximal-most aspect. One could also measure the anastomosis to accommodate a 60-mm stapler although it is usually sufficient to visualize this or even estimate this by placing the stapler adjacently. If so, the nearest most suture should be approximately 1 cm proximal to the 60-mm mark. The sutures should offset to the antimesenteric and antimesocolic aspect of the bowel by approximately 5 mm so as to allow for the anastomosis

to be placed along the antimesenteric and antimesocolic border once this stay suture is lifted anteriorly. We recommend performing the enterotomy and colotomy after lifting the stay suture toward the anterior abdominal wall through the assistant port in the epigastrium, using a Maryland grasper connected to the cautery and using the cut function at 40 W. The enterotomy and colotomy are performed between 5 and 7 mm posterior to the stay suture. This allows for a very sharp and precise enterotomy and colotomy to be performed. Care must be taken to avoid injuring the back wall and as such, staying superficial is always recommended. Once the enterotomy and colotomy have been created, the stapler can be passed through this area. We usually massage open each of these starting with the sharper smaller blade of the stapler and then to the larger blade so as to more easily accommodate both blades simultaneously when ultimately deploying stapler. We then retract the bowel into the base of the stapler so as to ensure that the entire 60 mm is deployed, while making sure that the bowel maintains the appropriate orientation. At times, adjusting the articulation of the tips of the stapler can assist with this. Care must be taken to visualize the tips of the stapler to avoid an injury. Once the stapler is deployed, we remove the stapler via the 5–12-mm port and subsequently remove a previously placed Ray-Tec gauze so as to clean the port of any stool. We then begin sewing the anastomosis posteriorly to anteriorly using a 3–0 barbed suture that is 6 inches in length. This allows us to more reassuringly confirm that the posterior aspect of the enterocolostomy has been secured with a stitch. We then sew a second layer using a 3–0 Vicryl suture in a Lembert fashion, cut to 25 cm so as to account for the increased length needed for the Lembert approach. Care must be taken to ensure a full thickness bite with the suture and to not take too much serosa (3–5 mm suffices) on the first layer to leave a sufficient amount of serosa for the second layer. Furthermore, care must be taken not to perform the enterotomy on the tinea so as to avoid the colotomy tearing with retraction which may affect the way in which the enterocolostomy is closed.

For the isoperistaltic approach, the technical aspects of the procedure are quite similar. After orienting the bowel in an antiperistaltic fashion, with the small bowel on the caudal aspect of the orientation and the transverse colon on the cephalad aspect, similar stay sutures are placed with the above principles. Subsequently, an enterotomy and colotomy are placed similar to the above. However, it is important to ensure that there is at least 2–3 cm between the staple line on the small bowel and the stay suture so as to accommodate the enterotomy and subsequently the enterocolostomy closure. The enterocolostomy is then sewn closed with similar principles listed above.

Technical risks

Regarding the risk of anastomotic leak, with the intracorporeal technique, specifically ensuring the staple line is on the antimesenteric aspect of the bowel, as well as securing the posterior aspect of the enterocolostomy during one's closure, the risk of anastomotic leak is significantly minimized. It is important to ensure appropriate vascularity to the anastomosis either with superficial assessments or with the addition of objective assessments using indocyanine green.

With regards to the concerns of twisting the anastomosis, this is very uncommon. Theoretically, it might be slightly more common with an antiperistaltic anastomosis although there is no evidence to this effect. In such an anastomosis, closing the mesenteric defect at the level of the visceral peritoneum overlying the mesentery could help. This is similar to how bariatric surgeons close the various mesenteric defects. It is often performed with a 2–0 or 3–0 silk suture in a running fashion. Alternatively, an isoperistaltic anastomosis, with the associated orientation of the mesentery and mesocolon, theoretically decreases the risk of any form of twisting of the anastomosis.

Discussion

Among SAGES and EAES survey respondents, 58% reported routinely performing ICA for minimally invasive right hemicolectomy. This was much higher than our initial projection and hypothesis that the majority of the respondents would report ECA adoption. The SAGES and EAES surgical communities represent a high volume of minimally invasive surgeons worldwide. Therefore, the ICA adoption rate of 58% among survey responders is likely subject to early adopter and self-selection bias among these groups of surgeons. We suspect that the current ICA adoption rate worldwide is likely much lower. However, this higher rate than expected, even in this group of early adopters of new technology surgical society members, demonstrates that the ICA technique is gaining increased interest and adoption into surgical practice. Notably, earlier studies examining ICA vs ECA during the era of predominantly laparoscopic colectomy demonstrated significantly lower ICA utilization rates [13, 14]. These discrepancies underscore the transformative impact of robotic systems, which offer enhanced dexterity, precision, and ergonomics, potentially lowering the technical barriers associated with laparoscopic ICA. The high ICA adoption rate in our survey likely reflects this evolution in technology, particularly as respondents were not asked to distinguish between laparoscopic and robotic approaches—a limitation that may overestimate ICA feasibility in non-robotic settings.

Participant responses in favor of ICA support the abundance of literature demonstrating that ICA is a safe technique with associated earlier tolerance of oral intake, return of bowel function and less pain [1–10]. When asked about leak rate, 51% participants noted similar rates between ICA and ECA which corroborates the current literature that demonstrates no statistically significant difference in leak rates [15]. Interestingly, over half of the participants who routinely perform ICA for right hemicolectomy also noted lower rates of SSI; however, this finding is not consistently demonstrated in the literature [15].

The survey response volume of 902 surgeons was also much higher than expected. This may be due to the passion of ICA early adopters in combination with an ongoing passionate reluctance among ECA minimally invasive hemicolectomy surgeons. Of the 902 respondents, 796 (88%) met the inclusion criteria and reported that they performed at least 20 laparoscopic or robotic segmental colectomies per year. The largest response rates were generated from membership distribution emails, and a very small number of respondents were from social media platforms for SAGES and EAES members. The combined membership in SAGES and EAES for 2023 and 2024 was 11,031 and 11,956, respectively. However, the precise number of surgeons who perform MIS colectomy is unknown as the membership in SAGES and EAES includes minimally invasive surgeons who specialize in foregut, hernia, bariatric, pediatric, surgical oncology, and colorectal surgery.

The majority of respondents performing ICA reported the highest rates of perceived benefits when performing ICA vs ECA in reduced patient postoperative pain reporting ($n=281$, 64%) and reduced rate of surgical site infections (274, 63%). While surgeon recall bias is significant among survey questionnaires such as this, it is interesting to see that these two outcomes were reported at a similar percentage rate. Anastomosis leak rate for ICA vs. ECA based on surgeon memory recall was the same (51%) or lower (30%) in the majority of respondents performing ICA. Seventeen percent reported not knowing if there was any difference in leak rate, and 1% reported a higher leak rate with ICA. Again, recall bias enters into all of these survey responses. However, the majority of respondents did not report an increase in anastomosis leak rate. When asked about the biggest hurdle to performing ICA, 139 (48%) of ECA respondents selected added operative time and/or cost in the operating room. These findings suggest a need for possible additional training & mentorship for surgeons looking to adopt ICA.

One of the most interesting findings among survey respondents was that there was no statistically significant association between the decade of training and the choice of surgical technique among surgeons taking the survey ($P=0.829$). This may be due to lack of universal ICA training programs during general surgical residencies and/or

fellowships, leaving interested surgeons to seek out their own individual training and/or mentorship. If this rationale is accurate, the rate of interest in ICA appears to be the same across all decades of training among respondents. Another possible explanation for the lack of significant difference in the reported decade of training and ICA vs. ECA preference may be due to the influence and infiltration of robotic surgical platforms into more and more hospitals over time, which facilitated the anastomotic techniques and overcome some of the ergonomic challenges with laparoscopic surgery.

There are several shortcomings with surveys. In this survey, respondents were not asked if they had access to a robotic surgical platform in their hospital system. In addition, respondents were not asked the percentage of robotic or laparoscopic ICA or ECA cases. Lastly, respondents were not asked about transanal endoscopic microsurgery (TEM) or transanal minimally invasive surgery (TAMIS) experience, which requires intracorporeal sutures skills, and may have provided further insight into the training and / or experience of respondents with intracorporeal suturing skills. Finally and as is indicated earlier, the respondents in this survey are likely to be early adopters and experts and may not reflect the whole surgical community's practice which affects the external validity of this study.

Nevertheless, the adoption of ICA for MIS right hemicolectomy is higher than hypothesized and has surpassed the 50% adoption rate in this subset of early adopter MIS surgeon respondents in the SAGES and EAES surgical communities. Factors influencing a surgeon's decision to not adopt ICA into their clinical practice included system issues as well as current evidence-based practice including added time and/or cost in the operating room, additional training, & additional mentorship before they would feel comfortable adopting ICA into clinical practice. Ongoing evaluation, outcome reporting, training and mentorship, as well as system support is encouraged as we continue to evaluate the anastomosis preference for MIS right hemicolectomy.

Supplementary Information The online version contains supplementary material available at <https://doi.org/10.1007/s00464-025-11929-5>.

Declarations

Disclosures Dr. Sami Chadi has received consulting fees and payment from Stryker Endoscopy unrelated to this manuscript. Dr. Daniel Popovich has disclosures unrelated to this manuscript as well. Drs. Nathan Aminpour, Elisabeth McLemore, Alberto Arezzo, Nader Francis, and Erin Schwarz have no conflicts of interest or financial ties to disclose.

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