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Expert consensus on robotic colorectal surgery in Türkiye: A modified Delphi study on indications, techniques, and future perspectives

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ABSTRACT

Introduction: Robotic surgery has become a cornerstone of minimally invasive colorectal surgery, offering enhanced visualization, greater dexterity, and improved ergonomics. However, variability in clinical practice and limited guideline coverage for niche areas highlight the need for expert-driven consensus, especially in countries like Türkiye where adoption is expanding but inconsistent.

Materials and Methods: A Modified Delphi process was used to generate expert consensus on key aspects of robotic colorectal surgery. A Scientific Committee of three experienced colorectal surgeons identified four main themes: Indications, education, operating room layout and positioning, and surgical technique and perioperative outcomes. Twenty-one evidence-based statements were developed employing the GRADE framework. These statements were presented and anonymously voted on by participants, predominantly colorectal and general surgeons, during a consensus session at the 17th National Endoscopic Laparoscopic Robotic Surgery Congress in Türkiye (October 2024). A consensus threshold was defined as ≥70% agreement for each statement.

Results: Of the total 21 statements, 15 reached consensuses, including 10 with strong agreement (>90%). Statements related to ergonomic superiority and long-term functional outcomes of robotic surgery received strong support. Topics such as the use of robotic surgery in high BMI patients, prior abdominal surgery, and vessel sealing for IMA showed lower agreement, reflecting a variety in practices and familiarity with robotic techniques. ERAS protocols, although integral to the future of robotic colorectal surgery, received limited support.

Conclusions: This study presents a national expert consensus on robotic colorectal surgery in Türkiye. The findings integrate current evidence with expert insight, offering guidance for clinical decision-making and education.

Keywords: Expert consensus, modified delphi method, robotic colorectal surgery

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Introduction

Robotic surgery has been widely adopted in various surgical specialties and has become an integral part of minimally invasive surgery.[1] This trend is driven by the continuous technological developments in robotic surgical equipment and auxiliary systems, along with their increasing accessibility. Robotic surgery offers many practical advantages such as superior visualization through 3D magnification and greater range of motion with seven degrees of freedom. In addition, the surgeon is seated, offering greater comfort and the elimination of fatigue related errors.[2] Robotic surgery is useful in colorectal surgery particularly in cases involving bulky tumors and anatomically challenging areas such as the pelvis. Robotic surgery can successfully overcome the motion limitations of laparoscopic surgery instruments in confined anatomical spaces. The literature on short and long-term outcomes of robotic colorectal surgery logarithmically expanded in recent years, reflecting a growing interest in enhancing surgical precision. Studies show that while robotic surgery does not demonstrate significant superiority over traditional techniques in perioperative complication rates, it is associated with improved long-term clinical outcomes. Oncological outcomes remain a topic of ongoing debate.[3]

As growing evidence on surgical practices and outcomes emerges, the need to define optimal practices becomes increasingly critical. Guidelines are considered the primary resources for synthesizing the most valuable evidence in literature, offering expert-based standardized recommendations. Nevertheless, physicians may need expert opinions on niche topics where existing guidelines may fail to provide sufficient information. Expert consensus studies and recommendation reports become useful in such cases, as they offer nuanced insights and consensus-based solutions upon the review of most recent evidence. In recent years, the number of expert consensus studies in colorectal and pancreatic surgery has notably increased. Among the various topics discussed by the experts, one of the key subtopics is the adoption of robotic surgery in these fields.[4-7]

Our aim was to conduct a consensus study that analyzes the current landscape of robotic colorectal surgery considering the experiences of Turkish colorectal surgeons, emphasizing hot topics, areas of ongoing debate, and potential future trajectories. By uniting expert perspectives, informed answers can be given for certain niche questions about robotic colorectal surgery, particularly in the context of Türkiye.

Method

A Scientific Committee comprising three colorectal surgeons was assembled, two of whom also served as facilitators. Members were selected based on their experience in colorectal surgery, expertise in robotic procedures, and academic involvement in minimally invasive surgery, with the aim of incorporating perspectives from different institutions.

The Committee held a meeting in March 2024 with the purpose of employing a Modified Delphi method. They established four main themes in which problems, hot topics, and open-to-debate points about robotic colorectal surgery were discussed, and (1) Indication, (2) Education, (3) Operating Room Layout and Positioning, (4) Surgical Technique and Perioperative outcomes were nominated as key themes. In the first meeting, forty questions were proposed by the Scientific Committee. With facilitator oversight, twenty-one final questions were selected across the main themes. In the next round, an extensive literature search was conducted through generated search strings for every question in PubMed to identify the best available evidence and formulate the statements. The process used for the identification of the selected literature is presented in Figure 1. The search strings used in PubMed are provided in the Appendix. Each statement was evaluated for the quality of evidence (based on consistent results from randomized trials, meta-analyses, or observational studies etc.) and grade of recommendation (based on benefits and risks) within the GRADE framework.[8] After the revision round, a presentation displaying the questions, statements, grades, and brief literature summary of each statement was prepared.

In October 2024, the 17. National Endoscopic Laparoscopic Robotic Surgery Congress was organized in Antalya, Türkiye by the Turkish Association for Endoscopic-Laparoscopic Surgery (ELCD). A robotic colorectal surgery consensus session was included in the congress program. In the beginning, one of the facilitators went over the statements and briefly explained findings in the literature. Subsequently, all registered participants in the session, predominantly colorectal and general surgeons, were invited to vote anonymously. Statements were displayed on the main screen via the online Kahoot platform and participants voted for agreement or disagreement on each statement. The threshold for consensus agreement was set at 70%. Agreement was defined as 70% and 90%, and values above 90% were considered strong agreement.

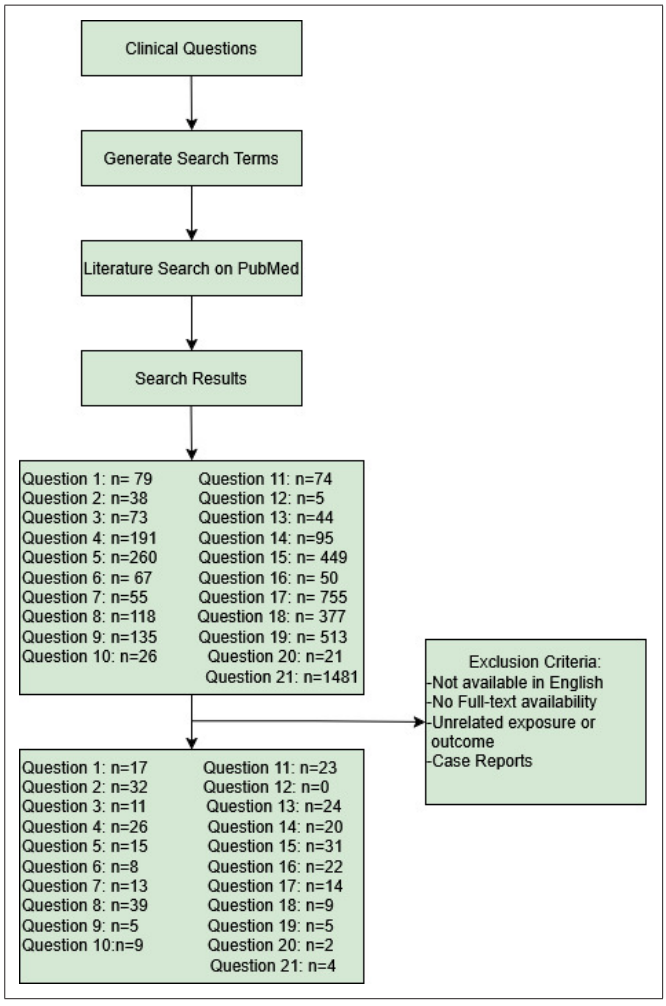


Figure 1. ELCD consensus Flowchart 1.

The methodological process, spanning from the planning stage to the consensus session, is presented in Figure 2.

Results

Twenty-one predefined statements on robotic colorectal surgery were evaluated using the Modified Delphi Method by a group of colorectal and general surgeons. The number of participants voting on each statement was between 48 to 54. Of twenty-one statements, six failed to reach the 70% agreement threshold, while fifteen achieved consensus. Notably, ten statements received strong agreement, with over 90% of participants voting in favor. The statements, along with their evidence quality and agreement rates, have been presented in Table 1. The statements that did not reach consensus have been discussed in the Discussion section.

Evaluations regarding indication issues were heterogeneous. High BMI and previous abdominal surgery were not regarded as absolute contraindications, but consensus could not be achieved on their feasibility. By contrast, there was near-unanimous agreement that 3D visualization in robotic surgery provides superior imaging in confined spaces such as the pelvis, and that robotic

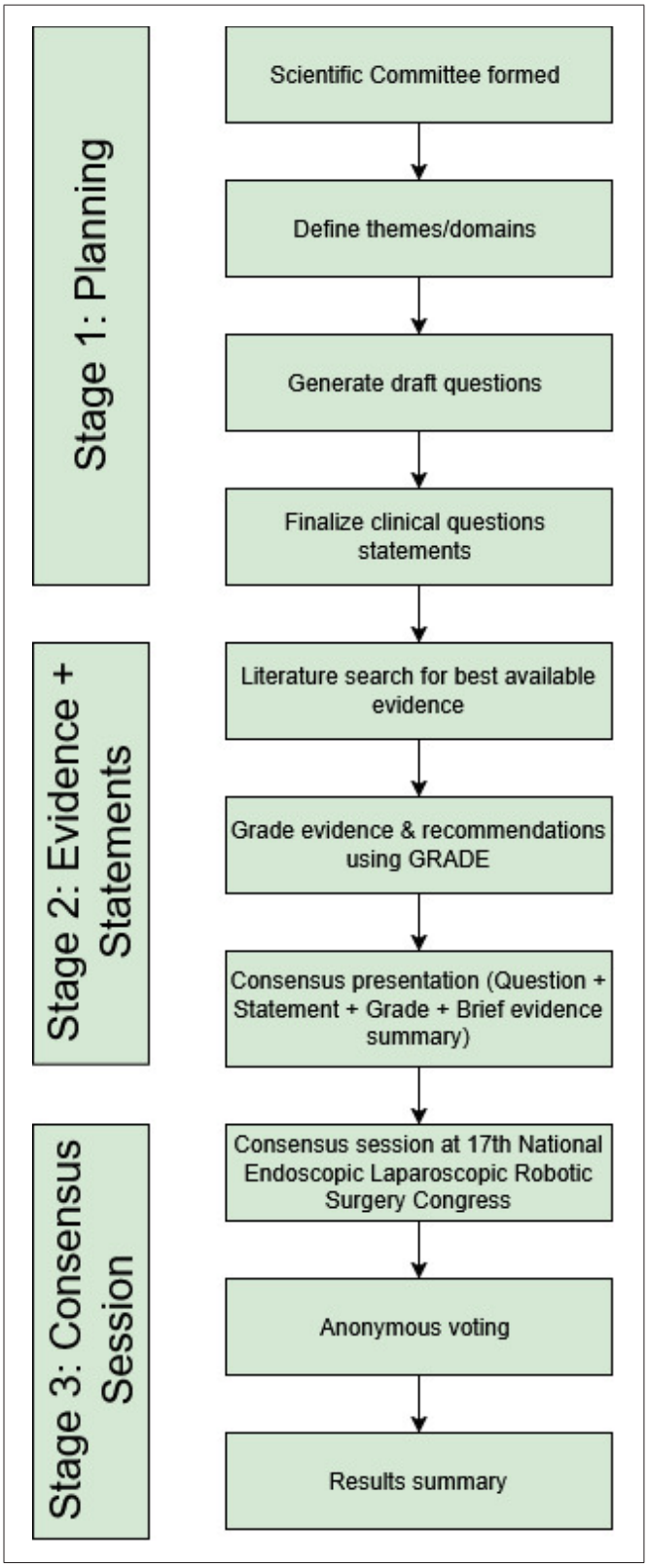


Figure 2. ELCD consensus Flowchart 2.

Table 1. Evidence-based statements on robotic colorectal surgery in Türkiye

	Question	Statement	Recommendation Level	Evidence Level	%
		Indication			
1)	Is BMI a contraindication for robotic rectal surgery?	Robotic rectal surgery in obese patients yields equivalent pathological results compared to non-obese patients. There is no significant difference in perioperative complications. Robotic surgery is a suitable option for patients with a high body mass index (BMI>25 kg/m²). In morbidly obese patients (BMI>35 kg/m²), it is also a viable option, but the decision should be made based on the individual patient.	1	B	54.17
2)	Does 3D imaging in robotic surgery provide better visualization than laparoscopy?	3D imaging offers better visualization, especially in confined spaces like the pelvis, compared to 2D imaging in laparoscopy.	1	A	97.92
3)	Is robotic surgery appropriate for simultaneous colorectal surgery and liver metastasectomy?	Robotic surgery is considered suitable for simultaneous colorectal resections and liver metastasectomies, although this is supported by a limited number of studies. It should be performed in specialized centers with adequate experience	2	C	91.84
4)	Is prior abdominal surgery a limiting factor for robotic colorectal surgery?	Previous surgeries are not a contraindication for robotic colorectal surgery. However, prior major surgeries may increase the risk of adhesions, which can complicate procedures. The decision should be tailored to the patient's condition.	1	C	55.1
		Education			
5)	How should robotic rectal surgery training be conducted?	Training should include supervised programs that incorporate simulation, practice on artificial tissues, training on large animal models, cadaver practice, and hands-on training under the supervision of experienced robotic surgeons.	1	B	95.83
6)	How should robotic rectal surgery training be monitored?	Robotic surgery training should be integrated into a certification program and subjected to centralized oversight. Certification should be renewed periodically.	1	C	75.51
7)	Should operating room staff undergo specialized training for robotic colorectal surgery?	Operating room staff must be trained to manage and operate the robotic system effectively. They should also be prepared for emergency interventions and remain consistent as a dedicated team wherever possible.	1	C	98.08

Table 1. Continue

	Question	Statement	Recommendation Level	Evidence Level	%
8)	Are courses and simulations sufficient for robotic colorectal surgery training?	Courses and simulation-based training are essential but need to be standardized. Moving from time-based training models to competency-based ones can enhance the quality of education.	1	B	75.0
		Operating Room Layout and Positioning			
9)	Should robotic port placement be standardized?	Port placement in robotic surgery should be standardized according to the operative site, ensuring that robotic arms do not collide during the procedure.	1	C	80.0
10)	Might the use of Integrated Table Motion (ITM) technology improve efficiency during robotic surgery?	ITM technology facilitates changes in the operating table's position during robotic surgery without the need for re-docking the robot. This can reduce surgery time and may improve efficiency and is encouraged based on team experience.	2	B	90.0
		Surgical Technique and Perioperative outcomes			
11)	Does robotic surgery offer a more comfortable experience for the surgeon compared to laparoscopy?	Robotic surgery provides a more comfortable experience for the surgeon compared to laparoscopic surgery.	1	B	97.96
12)	Can the Da Vinci Vessel Sealer® be used for sealing the inferior mesenteric artery?	The Da Vinci Vessel Sealer® can be used for vessels up to 7 mm in diameter but is not recommended for calcified arteries.	2	C	40.82
13)	Should indocyanine green (ICG) be used to assess anastomotic perfusion during robotic surgery?	When available, ICG can be used to assess tissue perfusion during anastomosis, potentially reducing the risk of leakage.	2	B	92.16
14)	Is robotic surgery a suitable option for transanal minimally invasive rectal surgery?	Current evidence does not indicate significant advantages of robotic surgery over laparoscopic techniques in transanal minimally invasive rectal surgery.	2	C	62.75
15)	Is robotic rectal surgery superior to laparoscopic rectal surgery in terms of complications?	Robotic surgery has a lower conversion rate to open surgery compared to laparoscopy but shows no significant differences in perioperative complications.	2	B	65.38
16)	Does robotic colorectal surgery improve quality of life and preserve urinary and sexual functions better than laparoscopy?	Robotic surgery may help preserve pelvic nerves and reduce the risk of urogenital dysfunction, offering advantages in maintaining urinary and sexual functions compared to laparoscopy.	2	B	90.38

Table 1. Continue

	Question	Statement	Recommendation Level	Evidence Level	%
16)	Does robotic colorectal surgery improve quality of life and preserve urinary and sexual functions better than laparoscopy?	Robotic surgery may help preserve pelvic nerves and reduce the risk of urogenital dysfunction, offering advantages in maintaining urinary and sexual functions compared to laparoscopy.	2	B	90.38
17)	Does artificial intelligence integration into robotic colorectal surgery provide surgical advantages?	AI-integrated robotic surgery can enhance precision, safety, and personalization while contributing to training and simulations.	2	C	92.31
18)	Is robotic surgery superior to laparoscopy in preventing positive surgical margins?	Robotic surgery demonstrates similar rates of positive surgical margins as laparoscopy.	2	C	73.08
19)	Does robotic colorectal surgery offer a survival advantage over laparoscopy?	Limited studies suggest that robotic surgery may provide a disease-free survival advantage over laparoscopy, but more randomized controlled trials are needed.	2	C	0.0[1]
20)	Does robotic colorectal surgery facilitate adherence to Enhanced Recovery After Surgery (ERAS) protocols better than laparoscopy?	Robotic surgery may improve adherence to ERAS protocols through shorter hospital stays, lower complication rates, and reduced conversion rates.	2	C	59.26
21)	Is robotic colorectal surgery likely to become the standard procedure in the future?	Robotic surgery is increasingly preferred due to its advantages in complex anatomical regions and its growing adoption, suggesting it may become the standard procedure in the future.	2	C	90.57

[1]The voting results could not be obtained due to an unforeseen error on 19th statement.

surgery is an appropriate option for simultaneous colorectal resection and liver metastasectomy, when performed in experienced centers. The participants strongly endorsed structured, stepwise training for robotic rectal surgery, combining simulation, artificial or animal models, cadaveric work, and supervised hands-on operating. There was agreement that such training should be integrated into a formal certification framework. Moreover, participants also agreed that operating room staff should receive formalized, dedicated robotic surgery setup training.

Standardization of operating room setup for robotic surgery was strongly favored. In particular, standardized port placement was recommended to reduce arm collisions and optimize efficiency. There was also high agreement that the use of Integrated Table Motion, when available and applied by experienced teams, can facilitate intraoperative repositioning without re-docking and thereby uninterrupted workflow.

Surgeons agreed that robotic surgery offers superior ergonomic comfort compared with laparoscopy and supported

the use of intraoperative indocyanine green angiography for anastomotic perfusion assessment where available. The panel reached consensus that robotic colorectal surgery may better preserve urinary and sexual function and that the incorporation of artificial intelligence into robotic systems is likely to enhance precision, safety, and training.

Discussion

In this modified Delphi-based consensus study on robotic colorectal surgery, we evaluated 21 statements across indications, training, operating room organization, and surgical technique. Overall, 15 statements reached the predefined consensus threshold, including 10 with very high agreement. A key strength of this work is that literature-based statements were systematically developed within predefined thematic domains and subsequently tested against the collective experience of Turkish surgeons, thereby generating guidance that is both evidence-informed and context-specific for Türkiye. Moreover, this approach enables the structured evaluation of topics that are often underrepresented in formal guidelines, where expert opinion is most valuable.

Only 54.17% of participants agreed that the robotic rectal surgery in obese patients yields equivalent pathological results compared to non-obese patients, without any difference in perioperative complications. However, meta-analysis studies show that perioperative complication rates and pathology metrics for robotic colorectal surgery do not display meaningful difference for obese and non-obese patients. Longer operative times have traditionally been recorded for obese patients, yet operative times have shortened since the introduction of robotic surgery.[9,10] Therefore, high BMI is not a contraindication for robotic colorectal surgery.

Only 55.1% of the surgeons agreed that previous surgeries are not a contraindication for robotic colorectal surgery. Contrary to these results, literature evidence demonstrates that prior abdominal surgery is not a contraindication to performing robotic colorectal surgery. A propensity score-matching analysis showed that patients with a history of abdominal surgery did not exhibit a greater incidence of postoperative complications or conversion to open surgery compared to those without such a history.[11] A meta-analyses demonstrated that robotic surgery has lower conversion rates compared to laparoscopic.[12] However, it has been well established that previous abdominal surgery can result in intraabdominal adhesions, which may alter the normal anatomy and complicate operative course, potentially leading to the conversion to open surgery in future minimally invasive abdominal surgeries. The Scientific Committee hypothesized that the divergence of voting could reflect differences in surgical cultures in which surgeons were trained. Senior surgeons were trained during a time where open surgery was the gold standard. Having adopted minimally invasive surgeries later in their careers, they may be more inclined to perceive minor challenges as significant risk factors for minimally invasive surgery.

Surgical Technique and Perioperative outcomes

The participants had a consensus that robotic surgery provides a more comfortable experience compared to laparoscopic surgery, with 97.96% agreement. Despite the very high level of agreement, it is important to note the ambiguous nature of this statement. Numerous studies have shown that robotic surgery provides ergonomic advantages over laparoscopic methods, significantly reducing both physical and mental strain.[13] A novel study objectively measuring the stress elicited by each modality demonstrated that robotic surgery results in lower salivary cortisol concentrations, indicating reduced stress for the surgeon compared to the laparoscopic method.[14] In addition, a randomized controlled study showed that robotic surgery caused significantly less stress in every part of the body except the back.[15] Particularly during longer surgeries, posture and prolonged position of head protruding towards the console may cause back and neck musculoskeletal injuries, highlighting a crucial consideration for long-term ergonomic outcomes.

Safe use of the Da Vinci Vessel Sealer® in vessels up to 7 mm in diameter received the lowest agreement rate with 40.82%. The literature on comparison of clipping versus sealing the inferior mesenteric artery (IMA) is very limited. Superiority of sealing the IMA over other ligation techniques has not been demonstrated. A theoretical threshold of 7 mm arterial diameter size was demonstrated by in vivo, and ex vivo models for sealing the arteries.[16] Furthermore, FDA approval of Da Vinci Vessel Sealer ® states that it should not be used above 7 mm arteries and warrants against the use in calcified arteries. Since the average diameter of the IMA is 4-6 mm, theoretically sealing is an appropriate option. However, the Scientific Committee believes that colorectal surgeons in Türkiye are inclined to follow traditional methods, such as clipping the IMA. This preference does not stem from the mistrust for robot-

ic surgery itself, but rather from skepticism toward the energy-sealing device or insufficient anatomical assessment of the diameter of IMA. It reflects a risk-averse approach among colorectal surgeons in Türkiye.

The lack of difference in significant advantages of robotic surgery over laparoscopic techniques in transanal minimally invasive rectal surgery was agreed upon by only 62.75% of the participants, even though available literature was sufficiently summarized. Robotic transanal minimally invasive rectal surgery (R-TAMIS) was first described in 2013. As the literature on this technique has been growing, it is considered an acceptable treatment option for early-stage rectal tumors. A recent systematic review has shown that R-TAMIS has a lower complication rate and lower margin positivity compared to the laparoscopic transanal minimally invasive rectal surgery (L-TAMIS).[17] Nevertheless, case series and cohort studies documented in the literature typically involve small populations, limiting the strength of evidence. To provide stronger evidence, large population randomized controlled trials are needed. This result could reflect a lack of awareness on R-TAMIS in Türkiye. Additionally, our statement focuses on comparisons with laparoscopic instruments, whereas endoscopic methods, such as endoscopic submucosal dissection (ESD) and endoscopic mucosal resection (EMR), are more commonly used for the resection of low-grade tumors. The emphasis on laparoscopic techniques may limit the scope of our argument and diminish its relevance to the context of current clinical practice.

Despite available evidence that robotic surgery has a lower conversion rate to open surgery compared to laparoscopy with no significant differences in perioperative complications, question 15 had a 65.38% approval rate, which failed to reach a consensus threshold by a slight margin. A meta-analysis of randomized controlled studies found no significant difference between robotic and laparoscopic methods for rectal cancer surgery in terms of postoperative complication rates, including anastomotic leakage, bleeding, surgical site infection, ileus, and urinary complications. Moreover, perioperative mortality rates were similar. However, robotic surgery was shown to cause less conversion to open surgery.[18] Another meta-analysis showed no substantial difference between surgical methods for the severity of complications by pooling the Clavien-Dindo grades reported.[19] The Scientific Committee suggested that variations in participants' experience with robotic colorectal surgery might have influenced the results, with less experienced surgeons potentially facing higher short-term complication rates. On the other hand, a strong agreement was established for the sixteenth statement, which highlights that colorectal surgeons recognize the long-term functional benefits of robotic surgery, particularly in preserving urinary and sexual functions.

Participants did not reach an agreement that robotic surgery may improve adherence to ERAS protocols through shorter hospital stays, lower complication rates, and reduced conversion rates, implying that majority of colorectal surgeons do not consider ERAS to be useful. The ERAS guidelines are a set of recommendations that aim to improve postoperative outcomes by establishing an individualized perioperative care program encompassing patient education and counseling, nutritional and physical activity assessment, psychological rehabilitation, and lifestyle recommendations.[20] The ERAS guideline for colorectal surgery was first published in 2005, with subsequent updates in 2012, 2018, and most recently in 2025, reflecting its growing global research interest. However, there are only a few publications from Türkiye regarding the implementation of ERAS in colorectal surgery. A recent study has shown that awareness of ERAS protocols is low amongst nurses and general surgeons. Moreover, only 2.98 % of participants reported implementation of ERAS protocols in their clinical practice. When participants were asked about the barriers against implementation of ERAS protocols; lack of information (18.1 %), requirement of a multidisciplinary team (16.6 %), and resistance to change (12.4 %) were among the most frequent responses.[21] On the other hand, growing interest in ERAS protocols at leading centers in Türkiye, advocating for the establishment of multidisciplinary "Prehabilitation Units" to ensure adoption of ERAS protocols.[22] In this context, it would be reasonable to speculate that there is both an interest in and a lack of information, as well as some degree of bias against ERAS protocols in Türkiye. Nevertheless, strong agreement on the twenty first statement highlights the belief that robotic surgery may become a standard procedure and suggests that with the implementation of ERAS protocols and the expansion of related literature, existing biases can be overcome in the future.

This study has several limitations. First, although the participants consisted of surgeons from different regions of Türkiye, the limited availability and uneven distribution of robotic platforms in the country implicate that not all participants have equal access or high-volume experience with robotic colorectal surgery. This disparity may have introduced selection and experience bias, the views of

surgeons working in centers with better access to robotic systems being overrepresented. In addition, as a Delphi-based consensus relying on expert opinion rather than patient-level outcome data, the statements should be interpreted as guidance to complement, rather than replace, evidence derived from prospective clinical studies.

Conclusion

This consensus study presents perspectives on the implementation and practice of robotic colorectal surgery, encompassing the collective knowledge of Turkish colorectal surgeons. The Modified Delphi framework used in this study aligns with international initiatives to standardize practices while considering regional differences, including varying levels of awareness and technology adoption. By focusing on niche topics within various categories of robotic colorectal surgery, it integrates evidence-based practices with expert insights. The findings aim to improve robotic colorectal surgery, enhance surgical precision, and foster innovation in surgical technology both in Türkiye and on an international scale.

Disclosures

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Appendix: *https://jag.journalagent.com/less/abs_files/LESS-75537/LESS-75537_(1)_Appendix.docx*

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