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WJGS mainly publishes articles reporting research results and findings obtained in the field of gastrointestinal surgery and covering a wide range of topics including biliary tract surgical procedures, biliopancreatic diversion, colectomy, esophagectomy, esophagostomy, pancreas transplantation, and pancreatectomy, etc.

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Robotic surgery in elderly patients with colorectal cancer: Review of the current literature

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Abstract

With an ageing global population, we will see an increasing number of elderly patients with colorectal cancer (CRC) requiring surgery. However, it should be recognized that the elderly are a heterogeneous group, with varying physiological and functional status. While traditionally viewed to be associated with frailty, comorbidities, and a higher risk of post operative morbidity, the advancements in minimally invasive surgery (MIS) and improvements in perioperative care have allowed CRC surgery to be safe and feasible in the elderly - chronological age alone should therefore not strictly be an exclusion criterion for curative surgery. However, as a form of MIS, laparoscopic assisted colorectal surgery (LACS) has the inherent disadvantages of: (1) Dependence on a trained assistant for retraction and laparoscope control; (2) The loss of wristed movement with reduced dexterity and suboptimal ergonomics; (3) A lack of intuitive movement due to the levering effect of trocars; and (4) An amplification of physiological tremors. Representing a technical evolution of LACS, robotic assisted colorectal surgery was introduced to overcome these limitations. In this minireview, we examine the evidence for robotic surgery in the elderly with CRC.

Key Words: Robotic surgery; Minimally invasive surgery; Colorectal cancer; Elderly; Geriatric; Frailty

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Core Tip: Robotic assisted colorectal surgery (RACS) is safe and feasible in the elderly. Despite an increased operative time, it potentially confers the benefit of lower conversion, earlier return of gut function and shorter length of stay with comparable oncological outcomes. As such, age alone should not be a specific exclusion criterion for RACS.

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INTRODUCTION

Globally, life expectancy has increased by more than 6 years between 2000 and 2019 - from 66.8 years in 2000 to 73.4 years in 2019. As such, the geriatric (age 65 and older) population is expected to expand exponentially[1]. The incidence of colorectal cancer (CRC) increases with age and the peak incidence has been reported to be between the 7th and 8th decade of life[2]. An estimate from the Surveillance, Epidemiology, and End Results database shows that approximately 70% of CRC develop over the age of 65, and about 40% of patients are over 75 years old[3]. Combining this age-specific incidence with a rapidly ageing population will result in a growing number of elderly patients with newly diagnosed CRC requiring surgery.

Despite being associated with multiple comorbidities[4], frailty[5], and sarcopenia[6], improvements in surgical technique and peri-operative care have made curative resection in the elderly safe and feasible[7]. One of these technological advancements is minimally invasive surgery (MIS). Studies have shown that the benefits of laparoscopy over open colorectal surgery are more pronounced in the elderly and the former has now become the standard of care in many countries[8,9]. However, the data for robotic colorectal surgery in the elderly remains comparatively scarce due to its slower uptake. This is partly due to concerns of adverse outcomes in the elderly from increased operative time and prolonged pneumoperitoneum associated with robotic surgery. In this review, we examine the operative and oncological outcomes for robotic colorectal surgery in elderly patients with CRC. Literature search was performed electronically using PubMed (MEDLINE) and the *Reference Citation Analysis* (<https://www.referencecitationanalysis.com>) was applied. The search terms were as follows: Elderly or old, CRC or colon cancer, and robotic surgery or robotic colectomy in combination with Boolean operators AND or OR. All studies published in English were extracted for review by the authors.

THE FRAIL ELDERLY AND RISK OF SURGERY

Most reports concur that CRC surgery in the elderly is associated with greater risks than in younger patients. The CRC Collaborative Group found that compared with their younger counterparts, the elderly tend to have more comorbidities and are more likely to present with late-stage disease requiring emergency surgery. These risk factors contribute to post operative morbidity and mortality[10]. They are also more likely to have had previous abdominal surgery, resulting in intra-abdominal adhesions that prolong operative time and increase the risk of iatrogenic injury[11].

Frailty is common in the elderly and is associated with an increased incidence of post-operative complications, prolonged hospitalization, greater 30-d mortality, and poorer overall survival (OS)[12]. Though there is no consensus definition of frailty, it is used to describe the syndrome of multisystem decline in physiological reserve which results in general debility, cognitive impairment, fatigue, weight loss, sarcopenia, low levels of physical activity, and progressive decline in body function and consequently the increased susceptibility of the patient to stress which can result in poor health outcomes[13-15].

However, it is important to note that frailty goes beyond age. Although it has been previously reported that advanced age itself is an independent risk factor for adverse outcomes, recent evidence suggests that it is not the chronological age of the patient but rather the quality of aging and the functional status that defines frailty and constitute a risk for surgery[16]. There is significant heterogeneity in the elderly with varying functional and physiological reserve and co-morbid states, hence tolerance to surgical stress can vary[17].

Comprehensive metrics have been used to distinguish between “frail” and “non-frail” patients to risk stratify elderly patients for surgery. At present, the Comprehensive Geriatric Assessment (CGA) is viewed as the gold standard for diagnosing frailty[18], and is recommended by the International Society of Geriatric Oncology. However, the CGA is time consuming and requires special training to assess. Other rapid frailty screening tools such as the image based Canadian Study of Health and Aging-Clinical Frailty Scale have been developed and can be utilized in the routine outpatient setting[19]. Risk stratification and medical optimization are important because it has been shown that a complicated postoperative course in the elderly has an adverse impact on survival in the first year after surgery[20], and for survivors of this early post-operative period of 1 year, cancer-related survival of the elderly is comparable to their younger counterparts[21,22].

While chronological age should not be a strict exclusion criterion for curative surgery in elderly patients with CRC, it should be recognized that the elderly patient has a more diverse and complex range of problems that puts him or her at an increased risk for surgery. As such, the importance of patient selection and treatment individualization cannot be overemphasized. For the frail elderly with limited life expectancy and poor functional reserve, it is perhaps reasonable to adopt a less aggressive approach to avoid the risks associated with radical surgery. Examples include palliative stoma or stenting for malignant large bowel obstruction, a watch and wait strategy after chemoradiation for rectal cancer, or surveillance in lieu of surgery for those with complete endoscopic removal of a malignant polyp. However, for those with a reasonable life expectancy and functional status, there is no compelling reason to deny them curative surgery based on age alone. If planned for surgery, this group of patients will benefit from multidisciplinary collaborative care involving geriatricians, anaesthetists, rehabilitation physicians, dietitians, and physiotherapists to deliver frailty targeted intervention programs to achieve better outcomes[23].

SURGICAL OPTIONS FOR CRC IN ELDERLY PATIENTS

The adage “Nothing beats good surgery!” holds true particularly for the elderly. The ideal operation for CRC would be one that: (1) Expedient; (2) Low morbidity; (3) Early return of gut function; (4) Acceptable pain profile that allows early ambulation; and (5) Good oncological outcome. When compared to open surgery, laparoscopic assisted colorectal surgery (LACS) for the elderly has been shown to be safe and feasible. Notwithstanding longer operative times, LACS conferred the benefits of less blood loss, reduced morbidity, faster return of bowel function and a shorter length of stay[24,25]. There was no difference in lymph node yield, disease specific survival and OS[25]. Studies by Frasson *et al*[8] and Hamaker *et al*[9] showed that the benefits of LACS were more pronounced in the elderly.

Unfortunately, there are inherent disadvantages in LACS. These include an unstable assistant-dependant view, loss of wristed movement with reduced dexterity, lack of intuitive movement due to the levering effect of trocars, and the amplification of tremors[26]. Also reported are poor ergonomic positions resulting in operator strain and lack of control over assistant’s traction[27]. These drawbacks are particularly apparent when performing total mesorectal excision (TME) in the narrow confines of the pelvis, resulting in a high rate of open conversion and potentially negating the benefits of MIS[28].

Representing a technical evolution of LACS, robotic assisted colorectal surgery (RACS) overcame many of its limitations. These include a stable surgeon-controlled 3D view, tremor elimination, increased manoeuvrability with EndoWrist technology, fixed stable traction, less physical strain and movement scaling which allows for greater precision in dissection and improved ergonomics for the surgeon[29,30]. Applied to TME, these advantages have been shown to reduce the risk of open conversion, post-operative complication, and length of stay[31]. Other studies have also shown that RACS provides superior visualization and more dynamic assistance than conventional laparoscopy in hemicolectomies[32]. It is therefore unsurprising that the uptake of RACS has increased dramatically over the past decade[33,34].

However, when compared to the general population, the uptake of RACS in the elderly has not been as rapid. This is due to concerns of the elderly being more susceptible to the stress of prolonged pneumoperitoneum from the increased operative time. Coupled with the steep Trendelenburg position required for rectal surgery, this can potentially result in adverse cardiovascular and respiratory complications[35]. Prolonged steep Trendelenburg has also been reported to result in ischemic optic neuropathy and raised intraocular pressure that potentially increase the risk of vision loss, especially in the elderly with pre-existing glaucoma[36].

SURGICAL OUTCOMES OF RACS IN THE ELDERLY

Despite these concerns, contemporary data seem to suggest that they are unfounded. We summarize the post operative outcomes of the available comparative studies between RACS and LACS in the elderly in Table 1[37,38] and with their younger counterparts in Table 2[39-42]. de’Angelis *et al*[38] reported that RACS took longer but Palomba *et al*[37] found that when subdivided by procedure, only colectomies had a longer operative time and there was no difference when TME was required. Despite this increase in operative time, no commensurate rise in intraoperative or postoperative cardio-respiratory complications or reports of vision loss were noted[37,38]. Furthermore, when compared to their younger counterparts, the elderly did not have a more complicated post operative course and there was no difference in 30-d mortality between the groups[39-42]. It is however important to note that these studies were limited by their retrospective nature and small numbers and were prone to bias. Till more conclusive data is available, it is prudent to ensure careful patient selection and medical optimization in the elderly.

Table 1 Robotic *versus* laparoscopic colorectal surgery in elderly studies

Ref.	Study type	Age cut-off	Number patients		Complication (%)			Conversion (%)			Operative time (min)			LOS (d)			Adequacy of resection and oncological outcomes
			RACS	LACS	RACS	LACS	P value	RACS	LACS	P value	RACS	LACS	P value	RACS	LACS	P value	
Palomba <i>et al</i> [37], 2022	Retrospective, comparative	65	32	51	25	29.4	0.66	3.1	13.7	0.35	RC = 238.5	RC = 183.5	0.004 ^a	RC = 6.6	RC = 6.3	0.26	No difference in LN yield and length of specimen
											LC = 249.6	LC = 211.7	0.003 ^a	LC = 4.2	LC = 5.8	0.004 ^a	
											RS = 276	RS = 270	0.87	RS = 3.7	RS = 6.2	0.003 ^a	
											RR = 302.8	RR = 291.7	0.12	RR = 5	RR = 7.1	0.003 ^a	
de'Angelis <i>et al</i> [38], 2018	Retrospective, PSM comparative	65	43	43	37.2	44.2	0.66	0	0	NA	300.6	214.5	0.034	11.7	14.8	0.079	No difference in LN yield. No difference in R0 resection. No difference in OS, DFS at 1,2 and 3 yr

^aP values < 0.05 were considered statistically significant.

LOS: Length of stay; LN: Lymph node; OS: Overall survival; DFS: Disease free survival; PSM: Propensity score matched; RACS: Robotic assisted colorectal surgery; LACS: Laparoscopic assisted colorectal surgery; RC: Right colectomy; LC: Left colectomy; RS: Rectosigmoid colectomy; RR: Rectal resection; NA: Not available.

Although not statistically significant, the open conversion rate was 4 times more for LACS (13.7% *vs* 3.1%) in Palomba *et al* [37]'s series. Similar trends have also been reported in the general adult population [26,31]. Intra-abdominal adhesions are often cited as a common reason for open conversion. In addition, adhesions increase operative time and the risk of iatrogenic bowel injury [11]. In this aspect, the elderly patient is particularly disadvantaged. Firstly, they are more likely to have had previous open surgery given that MIS was only mainstream in the past couple of decades, and secondly, they have an increased risk of adverse outcomes in the event of surgical complications and open conversion [20]. RACS has been shown to reduce the rates of open conversion in both colectomies [26] and TME surgery [31], especially in the setting of patients with intra-abdominal adhesions [43]. This potentially allows more elderly patients to benefit from MIS.

Compared to LACS, Palomba *et al* [37] reported a faster return of bowel function and reduced length of stay for left sided resection and those requiring TME. This is consistent with the results seen in the general adult population [31] and is probably a reflection of the superiority of the robotic platform in the narrow confines of the pelvis. These benefits have also been reported in robotic hemicolectomies and are theorized to be a consequence of greater precision of dissection, less bowel manipulation, and reduced tissue trauma when compared to the open or laparoscopic approaches. Furthermore, the reduced pain associated with more pivotal rather than tractional port manipulation results in less opiate use in RACS, allowing for an earlier recovery of gut function. The advantages of the robotic platform also lend itself well to intracorporeal anastomosis, which has been shown to reduce extraction site morbidity and

Table 2 Robotic colorectal surgery in elderly versus non-elderly

Ref.	Study type	Age cut-off	Number patients		Operative time (min)		P value	Complication (%)		P value	LOS (d)		P value	Oncological outcomes
			ELD	NELD	ELD	NELD		ELD	NELD		ELD	NELD		
Hannan <i>et al</i> [39], 2022	Retrospective, comparative	65	89	73	228	254	0.09	30.3	26	0.2	7	6	0.007 ^a	No difference in LN yield. No difference in R0 resection
Su <i>et al</i> [40], 2021	Retrospective, comparative	70	30	126	320	280	0.187	16.7	20.6	0.002 ^a	7	6	0.084	No difference in LN yield. No difference in R0 resection. No difference in OS and DFS
Oldani <i>et al</i> [41], 2017	Retrospective, comparative	70	RC = 9	RC = 6	NI	NI	NI	0	0	NI	5.22	5.66	NI	No difference in LN yield
			LC = 5	LC = 15				0	6.7		6.75	6.4		
			RR = 8	RR = 7				0	14.3		5.75	9.0		
Cuellar-Gomez <i>et al</i> [42], 2022	Retrospective, comparative	YO: 75-80; MO: 81-85; OO: ≥ 86	YO: 48; MO: 19; OO: 9		YO: 280; MO: 290; OO: 253		0.538	YO: 27.2; MO: 52.6; OO: 44.4		0.144	YO: 13.77; MO: 13.58; OO: 18.22		0.579	No difference in LN yield

^aP values < 0.05 were considered statistically significant.

ELD: Elderly; NELD: Non-elderly; LOS: Length of stay; LN: Lymph node; OS: Overall survival; DFS: Disease free survival; RC: Right hemicolectomy; LC: Left hemicolectomy; RR: Rectal resection; NI: No information; YO: Youngest-old; MO: Middle-old; OO: Oldest-old.

shorten the length of stay[44].

Oncological surgery should not be compromised in the elderly. In fact, some may argue that it is perhaps more essential given that pre-existing comorbidities may preclude them from adjuvant systemic therapy. The adequacy of resection for RACS is comparable to LACS in terms of lymph node yield and the percentage of R0 resections in the elderly[37,38]. de'Angelis *et al*[38] also reported no differences in OS and disease-free survival (DFS) up till 3 years. This is in keeping with current evidence for RACS in the adult population, which show no difference in terms of 5-year OS, DFS and local recurrence[45,46]. Complete mesocolic excision (CME) with central vascular ligation (CVL) for colonic cancer was first described by Hohenberger *et al*[47] and has been shown to have better quality surgical specimens and is associated with superior long term oncological outcomes[48]. The superior optics, stable retraction and dexterous dissection provided by the robotic platform makes it well suited to perform CME and CVL safely[49].

CONCLUSION

Early results from comparative studies show that RACS is safe and feasible in the elderly and despite an increased operative time, it potentially confers the benefit of lower conversion, earlier return of gut

function and shorter length of stay with comparable oncological outcomes. As such, age alone should not be a strict exclusion criterion for RACS.

FOOTNOTES

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