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included demographics such as age at time of surgery, gender, American Society of Anesthesiology (ASA) grading and body mass index (BMI). Furthermore, data collected from the procedure included type and length of procedure, conversion to open, length of stay, perioperative morbidity using the Clavien-Dindo score, re-operations, 90-day re-admission and 90 -day mortality rates. In addition to the above-mentioned data, other factors such as tumor staging (TNM), use of neo-adjuvant and adjuvant chemotherapy (CT) and/or radiotherapy (RT) and height of the tumor from the anal verge in left colorectal resections were also included. All patients were discussed in the multidisciplinary tumor board meeting, both pre- and postoperatively. This discussion encompassed all clinical aspects related to the patient's disease, such as prognosis and treatment planning. Following the meeting, all patients were included in a nurse-led colorectal cancer follow-up programme according to their tumor stage. The authors limited patient inclusion to May 2022 to ensure a 90-day follow-up period was available for the analysis of short-term postoperative outcomes.

The statistical analysis was conducted using the Chi-squared or Fisher's exact test for categorical data and the Wilcoxon test for continuous data.

Results

Patient demographics

A total of 228 patients were included in our study. 61 of these patients were ≥ 75 years old (elderly group), while 167 were < 75 years old (non-elderly group). The mean age of the elderly group was 78.8 (standard deviation 3.24), and that of the non-elderly group was 62.6 (standard deviation 9.27). No significant differences were observed among the two groups in terms of gender distribution, body mass index (BMI), number of patients who had previous abdominal operations, TNM stage, and the percentage of patients who had undergone neoadjuvant/adjuvant radiotherapy and/or chemotherapy (Table 1).

Analysis of patient characteristics revealed notable significant differences between the elderly and non-elderly age groups. Specifically, 41.7% of patients in the elderly group had an American Society of Anesthesiologists (ASA) score of 3 or higher, while only 19.6% of patients in the non-elderly group had an ASA score of 3 or higher ($p < 0.001$). In addition, 81.4% of operations in the non-elderly group were left-sided, compared to only 50% of operations in the elderly group ($p < 0.001$) (Table 1).

Overall operative outcomes

Our study revealed that there was no statistically significant difference between the two age groups regarding their overall operative outcomes, except for the duration of the operation. The duration of the operation was significantly

Characteristics	≥ 75 years (n = 61)	< 75 years (n = 167)	*p* values
Age, mean (SD)	78.80 (3.24)	62.61 (9.27)	< 0.001
Gender, n (%)			
Male	27 (44.3%)	96 (57.5%)	0.105
Female	34 (55.7%)	71 (42.5%)	
BMI, n (%)			
Normal weight (< 25.0)	16 (26.7%)	38 (22.9%)	
Overweight (25.0–29.9)	32 (53.3%)	73 (44.0%)	0.329
Obesity class I (30.0–34.9)	8 (13.3%)	41 (24.7%)	
Obesity class II (35.0–39.9)	4 (6.7%)	11 (6.6%)	
Obesity class III (40.0+)	0 (0.0%)	3 (1.8%)	
ASA, n (%)			
1	0 (0.0%)	13 (8.0%)	<0.001
2	35 (58.3%)	118 (72.4%)	
3	25 (41.7%)	32 (19.6%)	
T, n (%)			
0	1 (3.7%)	8 (4.8%)	
1	4 (6.9%)	23 (13.9%)	0.133
2	9 (15.5%)	32 (19.3%)	
3	34 (58.6%)	91 (54.8%)	
4	10 (17.2%)	12 (7.2%)	
N, n (%)			
0	43 (74.1%)	110 (66.3%)	0.507
1	10 (17.2%)	41 (24.7%)	
2	5 (8.6%)	15 (9.0%)	
M, n (%)			
0	59 (96.7%)	164 (98.8%)	0.293
1	2 (3.3%)	2 (1.2%)	
CT/RT, n (%)			
Yes	3 (4.9%)	9 (5.4%)	1
No	58 (95.1%)	158 (95.2%)	
Operation type, n (%)			
Left	30 (50.0%)	136 (81.4%)	< 0.001
Right	30 (50.0%)	31 (18.6%)	
Stoma, n (%)			
Yes	17 (27.9%)	60 (36.1%)	0.313
No	44 (72.1%)	106 (63.9%)	
Previous abdominal surgery, n (%)			
Yes	23 (37.7%)	48 (28.7%)	0.258
No	38 (62.3%)	119 (71.3%)	

Table 1: Patient demographics

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Outcome	≥ 75 years (n = 61)	< 75 years (n = 167)	*p* values
Duration of the Operation (in mins)	275.35 (90.90)	315.14 (92.59)	<0.001
mean (SD)			
Length of Hospital Stay (in days)	6.82 (6.67)	5.98 (6.25)	0.054
mean (SD)			
Conversion to Open			1
Yes	0 (0.0%)	1 (0.6%)	
No	60 (100.0%)	166 (99.4%)	
Morbidity			0.668
0	30 (50.0%)	97 (58.1%)	
1	8 (13.3%)	17 (10.2%)	
2	18 (30.0%)	40 (24.0%)	
3	4 (6.7%)	10 (6.0%)	
4	0 (0.0%)	3 (1.8%)	
Leak			0.076
Yes	1 (1.6%)	15 (9.0%)	
No	60 (98.4%)	152 (91.0%)	
Mortality (within 90 days)			0.268
Yes	1 (1.6%)	0 (0.0%)	
No	60 (98.4%)	167 (100.0%)	
Readmission			0.764
Yes	3 (5.0%)	12 (7.2%)	
No	57 (95.0%)	155 (92.8%)	
Reoperation			1
Yes	1 (1.7%)	5 (3.0%)	
No	59 (98.3%)	162 (97.0%)	

Table 2: Univariate analysis of the operative outcomes in robotic colorectal cancer surgery between the elderly and non-elderly groups

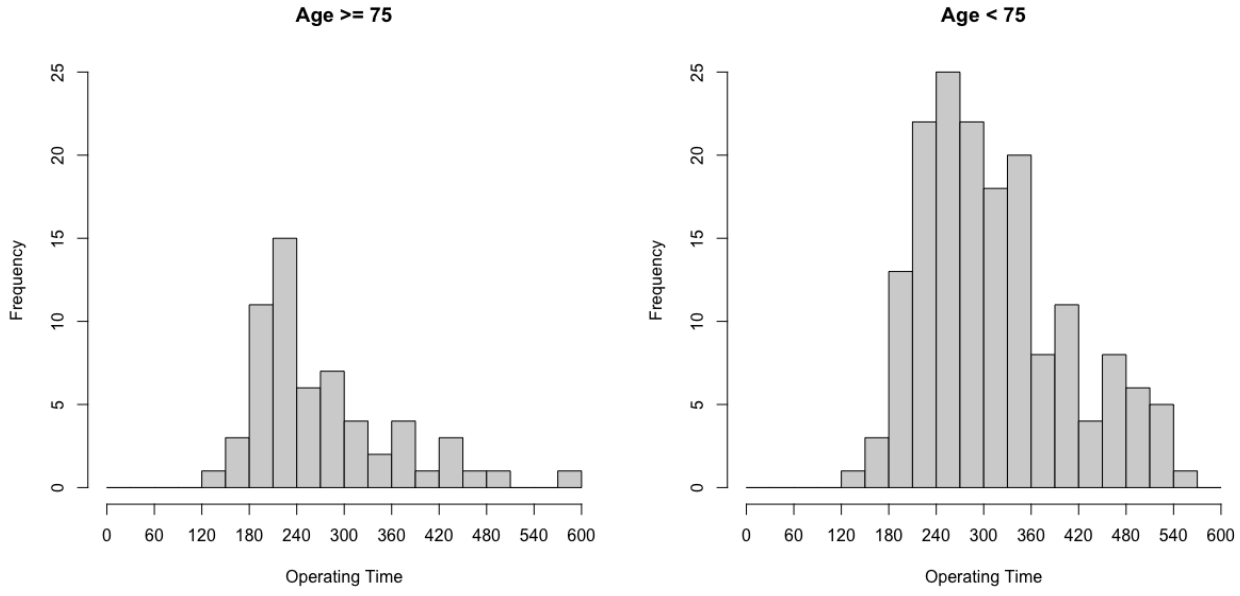

Figure 1: Operative time in robotic colorectal cancer surgery

Citation: Mazin Hamed, Melanie Holzgang, Yining Chen, Wanda Ward, Dolly Dowsett, Irshad Shaikh, Ahmed El-Hadi. Robotic colorectal cancer surgery in the elderly - A monocentric analysis of short-term postoperative outcomes in patients ≥ 75 years versus <75 years. Journal of Surgery and Research. 6 (2023): 39 - .

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lower in the elderly group (mean time 275.35 minutes vs. 315.14 minutes; $p < 0.001$) (Table 2) (Figure 1).

In addition, the results of our study showed that there were no statistically significant differences between the two groups when it came to conversion rates, postoperative morbidity and mortality, and 90-day re-admission or re-operation rates.

In terms of length of hospital stay, the mean for the elderly group was 6.82 days compared to 5.98 days in the non-elderly group, though the difference did not reach statistical significance (Figure 2). Similarly, the anastomotic leak rate was 1.5% in the elderly group (1/61) versus 9.0% in the non-elderly group (15/167), but the difference was not statistically significant ($p = 0.076$).

Operative outcomes in robotic left segmental colectomies

The results of left and right robotic colonic cancer resections for elderly and non-elderly patients were analysed separately and summarized in tables 3 and 4. For the left-sided resections, 30 elderly patients and 136 non-elderly patients underwent high/low anterior resection, segmental colectomy for splenic flexure cancers or abdominoperineal resection.

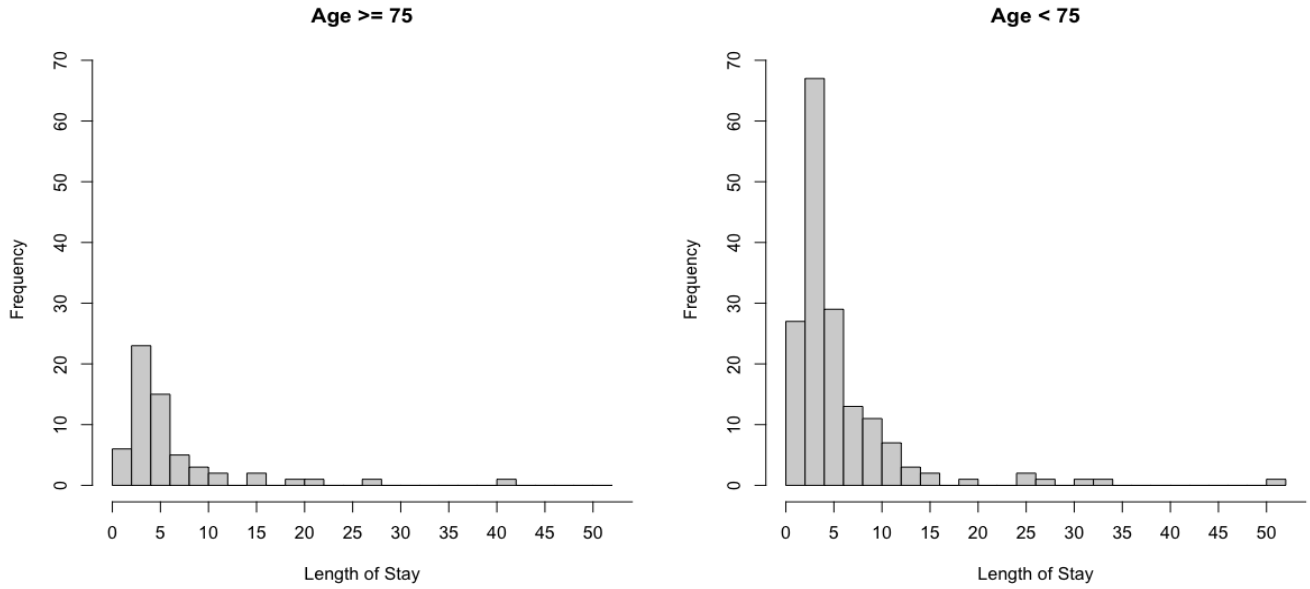

Figure 2: Length of hospital stay in robotic colorectal cancer surgery

Outcome	≥ 75 years (n = 30)	< 75 years (n = 136)	*p* values
Duration of the Operation (in mins)	314.66 (110.14)	327.76 (91.59)	0.347
mean (SD)			
Length of Hospital Stay (in days)	7.72 (8.15)	6.08 (6.76)	0.054
mean (SD)			
Conversion to Open			1
Yes	0 (0.0%)	1 (0.7%)	
No	29 (100.0%)	135 (99.3%)	
Morbidity			0.254
0	13 (44.8%)	82 (60.3%)	
1	3 (10.3%)	13 (9.6%)	
2	12 (41.4%)	29 (21.3%)	
3	1 (3.4%)	9 (6.6%)	
4	0 (0.0%)	3 (2.2%)	
Leak			0.075
Yes	0 (0.0%)	15 (11.0%)	
No	30 (100.0%)	121 (89.0%)	
Mortality (within 90 days)			1
Yes	0 (0.0%)	0 (0.0%)	
No	30 (100.0%)	136 (100.0%)	
Readmission			0.694
Yes	1 (3.4%)	11 (8.1%)	
No	28 (96.6%)	125 (91.9%)	
Reoperation			0.588
Yes	0 (0.0%)	5 (3.7%)	
No	29 (100.0%)	131 (96.3%)	

Table 3: Univariate analysis of the operative outcomes in robotic left segmental colectomies between the elderly and the non-elderly groups

Citation: Mazin Hamed, Melanie Holzgang, Yining Chen, Wanda Ward, Dolly Dowsett, Irshad Shaikh, Ahmed El-Hadi. Robotic colorectal cancer surgery in the elderly - A monocentric analysis of short-term postoperative outcomes in patients ≥ 75 years versus <75 years. Journal of Surgery and Research. 6 (2023): 39 - .

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The results for left robotic colorectal cancer resections show that there were no significant differences between elderly and non-elderly patients in any of the outcomes that were analyzed. Operating time, length of hospital stay, conversion to open surgery, postoperative morbidity and anastomotic leak rate were comparable between the two groups. The 90-day mortality/re-admission and re-operation rates were also similar for the elderly and non-elderly patients (Table 3) (Figures 3,4).

Of note, the operative time was shorter in the elderly group compared to the non-elderly group (314.66 minutes vs. 327.76 minutes), but this did not reach statistical significance (p = 0.347). Similarly, the length of hospital stay was over a day longer in the elderly group (7.72 vs. 6.08), however, this was also not statistically significant (p = 0.054). The absolute rate of anastomotic leaks was higher in the non-elderly group (11% vs. 0%), yet again no statistically significant difference was found (p = 0.075). Moreover, the rate of re-admission and re-operation were both higher in the non-elderly group than in the elderly group, but the difference did not reach statistical significance (Table 3).

Operative outcomes in robotic right segmental colectomies

The results of our study showed no significant difference in postoperative outcomes between the elderly and non-

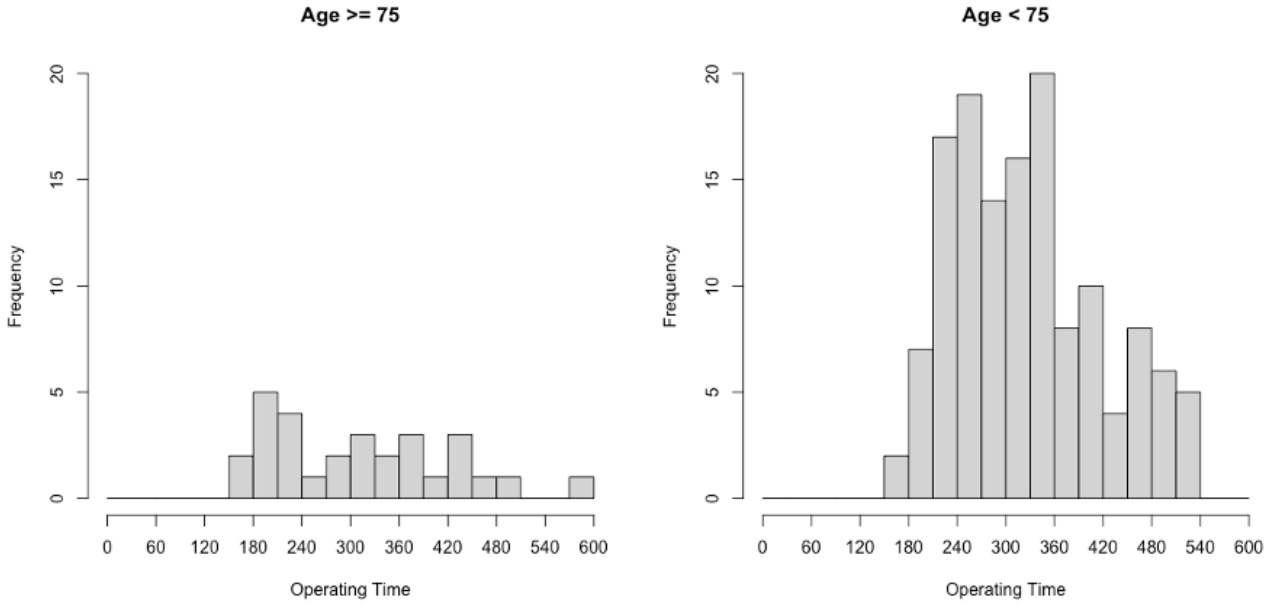

Figure 3: Operative time in robotic left segmental colectomies

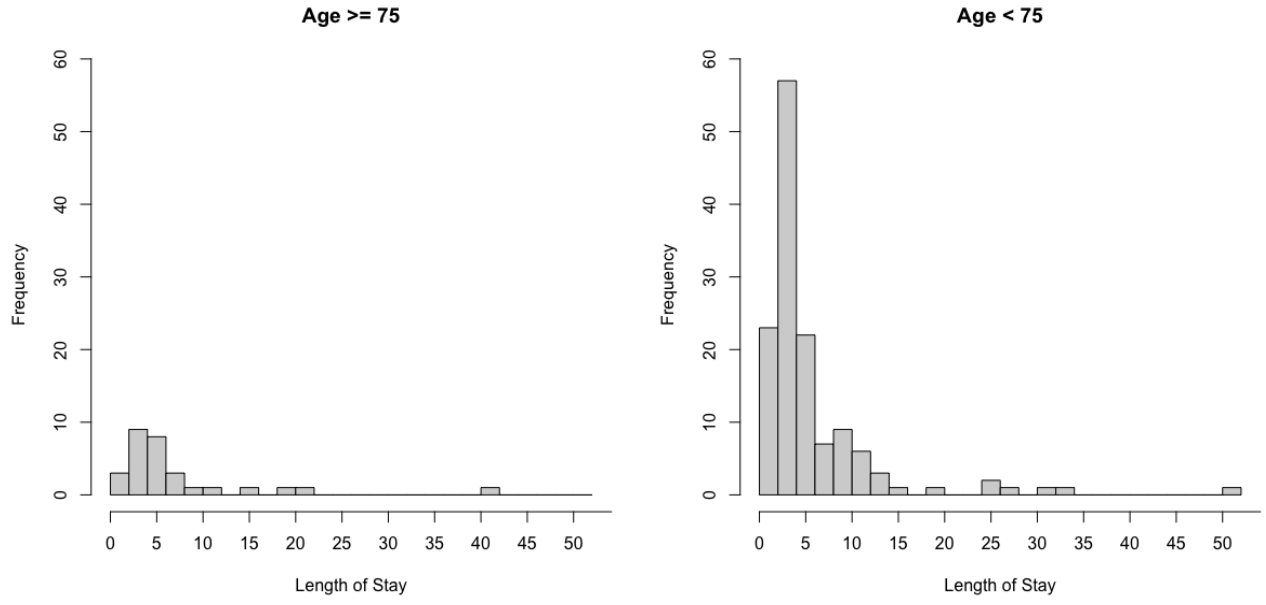

Figure 4: Length of stay after robotic left segmental colectomies

Citation: Mazin Hamed, Melanie Holzgang, Yining Chen, Wanda Ward, Dolly Dowsett, Irshad Shaikh, Ahmed El-Hadi. Robotic colorectal cancer surgery in the elderly - A monocentric analysis of short-term postoperative outcomes in patients ≥ 75 years versus <75 years. Journal of Surgery and Research. 6 (2023): 39 - .

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Table 4: Univariate analysis of the operative outcomes in robotic right segmental colectomies between the elderly and the non-elderly groups

Outcome	≥ 75 years (n = 30)	< 75 years (n = 31)	*p* values
Duration of the Operation (in mins) mean (SD)	239.13 (45.81)	259.81 (76.20)	0.363
Length of Hospital Stay (in days) mean (SD)	5.63 (4.59)	5.52 (3.22)	0.867
Conversion to Open			1
Yes	0 (0.0%)	0 (0.0%)	
No	30 (100.0%)	31 (100.0%)	
Morbidity			0.557
0	17 (56.7%)	15 (48.4%)	
1	5 (16.7%)	4 (12.9%)	
2	6 (20.0%)	11 (35.5%)	
3	2 (6.7%)	1 (3.2%)	
4	0 (0.0%)	0 (0.0%)	
Leak			0.492
Yes	1 (3.3%)	0 (0.0%)	
No	29 (96.7%)	31 (100.0%)	
Mortality (within 90 days)			0.492
Yes	1 (3.3%)	0 (0.0%)	
No	29 (96.7%)	31 (100.0%)	
Readmission			0.612
Yes	2 (6.7%)	1 (3.2%)	
No	28 (93.3%)	30 (92.8%)	
Reoperation			0.492
Yes	1 (3.3%)	0 (0.0%)	
No	29 (96.7%)	31 (100.0%)	

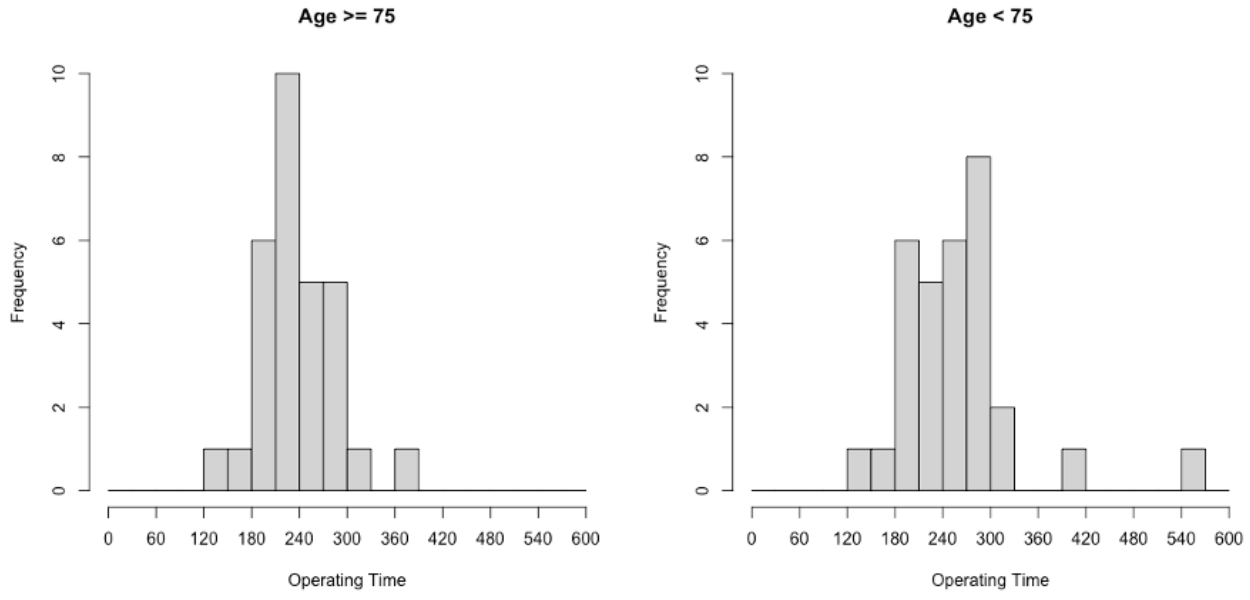

Figure 5: Operative time in robotic right segmental colectomies

Citation: Mazin Hamed, Melanie Holzgang, Yining Chen, Wanda Ward, Dolly Dowsett, Irshad Shaikh, Ahmed El-Hadi. Robotic colorectal cancer surgery in the elderly - A monocentric analysis of short-term postoperative outcomes in patients ≥ 75 years versus <75 years. Journal of Surgery and Research. 6 (2023): 39 - .

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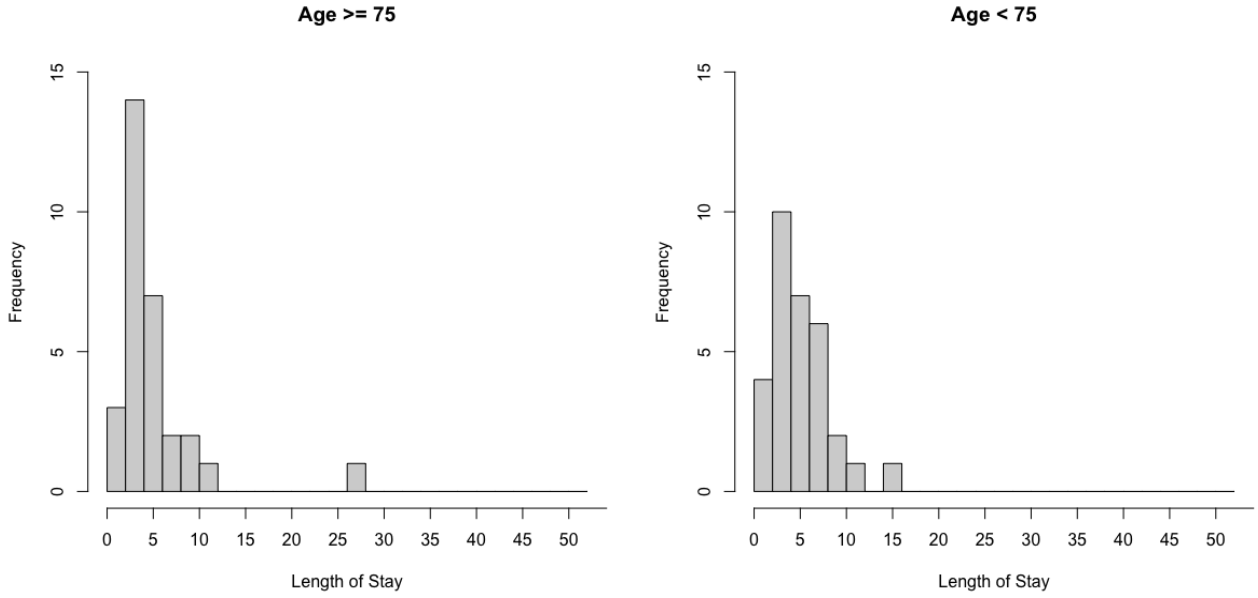

Figure 6: Length of hospital stay in robotic right segmental colectomies

elderly patients in those who underwent robotic right colonic cancer resection (Table 4). Absolute operative times for elderly patients were shorter, though not statistically significant (239.13 minutes compared to 259.81 minutes in the non-elderly group; p=0.363). Length of hospital stay, re-admission and re-operation rates, postoperative morbidity and mortality were also comparable between groups (Table 4, Figures 5,6).

Discussion

Colorectal cancer is one of the most common forms of cancer in Europe, affecting both men and women. According to data from 2020, it is the second most common cancer in women (12.4%) and third most common cancer in men (13.2%). It is most prevalent among the elderly population, and with the trend of "population ageing" set to continue in the coming decades, it is likely that this age group will be increasingly affected by colorectal cancer [22].

Robotic platforms are becoming increasingly popular in colorectal surgery departments all over the world, as evidence suggests that they may offer a shorter hospital stay and faster return to bowel function than laparoscopic surgery [10, 11,14]. Moreover, with the increasing use of robotic platforms in the elderly population, studies have shown that robotic procedures are generally well-tolerated by the elderly [14-16]. While the assumption may be that robotic colorectal surgery in elderly patients results in poor postoperative outcomes due to longer operating times and longer static Trendelenburg positioning; evidence suggests otherwise. Studies have shown that elderly patients are well-tolerated in robotic surgeries, with equal morbidity rates compared to other groups, lower conversion rates and shorter hospital stays [7,17,18]. These results demonstrate the efficacy of robotic surgery in elderly patients and highlight its potential in this population.

Our study, which analyzed the outcomes of 61 elderly patients (aged ≥75) and 166 non-elderly patients (aged <75) in robotic colorectal cancer operations, supports the existing literature with no significant differences found. Length of hospital stay, postoperative morbidity/mortality, anastomotic leaks and conversion rates did not differ between the two groups, indicating that robotic colorectal cancer surgery is feasible and safe in elderly patients. This data provides further evidence that age should not be a deterrent when considering robotic colorectal cancer surgery for elderly patients.

The results of our study demonstrated that elderly individuals had a trend towards shorter operative times when compared to non-elderly individuals. We initially interpreted this as selection bias as a relatively higher number of right-sided operations were done in the elderly group which usually takes less time. However, when looking specifically at the analysis of left and right colectomies, there was still a slight reduction in operative times for the elderly individuals for both types of operations, although this was not statistically significant. These results challenge the notion that robotic procedures in elderly individuals are often longer and more technically challenging.

A closer look at the absolute numbers revealed a lack of statistical significance difference in hospital stay between the two groups. However, the elderly group stayed over a day longer after left robotic colorectal resections compared to the non-elderly group, which is clinically significant. This phenomenon is likely because the elderly group had

significantly higher comorbidities than the non-elderly group. These comorbidities may impede the postoperative recovery process and thus, delay the length of hospital stay. The findings from this study demonstrate that comorbidities should be considered when considering the care of elderly patients undergoing left robotic colorectal resections.

Our study showed that there was no statistically significant difference between the elderly and non-elderly groups when it came to postoperative morbidity, notably anastomotic leaks. However, the absolute number of anastomotic leaks in the non-elderly group was higher than that of the elderly group, and similarly, re-admission and re-operation rates were higher in the non-elderly group. One explanation for this could be that the non-elderly group had more left-sided colectomies performed than the elderly group. To back up this hypothesis, it was found that operative time, re-admission and re-operative rates were nearly equivalent between the two groups in the right-sided colectomies.

This study has several limitations. It was a non-randomized, retrospective and monocentric study. In addition, the sample size in the elderly population group is relatively small. Although it is larger than Wei-Chi et al.'s group study and comparable numbers to Hannan E et al. and Cuellar-Gomez et al.'s studies [19-21] which showed very similar results with no differences in the outcomes. Due to the small sample size definitive conclusions cannot be drawn. In order to definitively confirm these results, a larger multicenter or randomized controlled study would have to be conducted. Such a study could provide more insight into the potential benefits and limitations of the studied intervention. Thus, any conclusions must be interpreted with caution. Despite these limitations, the findings of this study are very promising and could potentially lead to improved outcomes for elderly patients.

Conclusion

Our study results on robotic colorectal cancer surgery in elderly patients suggest that it is a safe and feasible surgical approach. The operative times and short-term postoperative outcomes of elderly patients were comparable to those of the non-elderly group. This indicates that robotic colorectal cancer surgery is a viable option for elderly patients.

Conflict interest

The authors have no relevant financial or non-financial interests to declare.

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Not applicable.

Author contributions

All authors contributed to the study conception and design. Material preparation and data collection were performed by Melanie Holzgang, Mazin Hamed, Wanda Ward, Dolly Dowsett, Irshad Shaikh and Ahmed El-Hadi. Data analysis was performed by Yining Chen. The first draft of the manuscript was written by Melanie Holzgang, Mazin Hamed and Yining Chen and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

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