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ORIGINAL ARTICLE

Case Control Study

Colorectal resections for malignancy: A pilot study comparing conventional *vs* freehand robot-assisted laparoscopic colectomy

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Abstract

BACKGROUND

Laparoscopic colectomy is widely accepted as a safe operation for colorectal cancer, but we have experienced resistance to the introduction of the FreeHand® robotic camera holder to augment laparoscopic colorectal surgery.

AIM

To compare the initial results between conventional and FreeHand® robot-assisted laparoscopic colectomy in Trinidad and Tobago.

METHODS

This was a prospective study of outcomes from all laparoscopic colectomies performed for colorectal carcinoma from November 29, 2021 to May 30, 2022. The following data were recorded: Operating time, conversions, estimated blood loss, hospitalization, morbidity, surgical resection margins and number of nodes harvested. All data were entered into an excel database and the data were analyzed using SPSS ver 20.0.

RESULTS

There were 23 patients undergoing colectomies for malignant disease: 8 (35%) FreeHand®-assisted and 15 (65%) conventional laparoscopic colectomies. There were no conversions. Operating time was significantly lower in patients undergoing robot-assisted laparoscopic colectomy (95.13 ± 9.22 *vs* 105.67 ± 11.48 min; *P*

= 0.045). Otherwise, there was no difference in estimated blood loss, nodal harvest, hospitalization, morbidity or mortality.

CONCLUSION
The FreeHand® robot for colectomies is safe, provides some advantages over conventional laparoscopy and does not compromise oncologic standards in the resource-poor Caribbean setting.

Key Words: Laparoscopic; Colectomy; Robot; Surgery; Minimally invasive

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Core Tip: The FreeHand® single arm robot is a viable option to conventional laparoscopy for colorectal surgery. The Free hand robot is safe for colectomy and does not compromise oncologic standards in the resource-poor Caribbean setting.

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INTRODUCTION

There is level 1 data in support of a laparoscopic approach to colorectal surgery[1-12]. During a laparoscopic colectomy, the surgeon uses both hands to control operating instruments, while a separate camera person controls the laparoscope. Due to staff shortages at our institution, and compounded by the concern of crowding in the operating room during the 2021 pandemic, camera persons were unavailable and this impaired our ability to perform laparoscopic surgery. In response, the FreeHand® (Freehand 2010 Ltd., Guildford, Surrey, United Kingdom) robotic camera holder was introduced to our facility at the Port of Spain General Hospital in Trinidad and Tobago to augment laparoscopic colorectal surgery.

The FreeHand® robot is a single robotic arm that is docked at the operating bed rail and is used to control the laparoscope. The operating surgeon is in direct control of the robotic arm *via* a head-mounted radiofrequency communicator that responds to the surgeon's head movements. The robot controls are intuitive as they respond to the direction in which the surgeon's head moves, mirroring the direction of vision. The requirement for a human camera person is now obviated because the surgeon can control operating instruments in both hands and simultaneously control the laparoscope using head movements. The advantage is an accurate and stable view of the operating field, eliminating human error by the camera person[13].

The first FreeHand® robot-assisted colorectal operation in the Caribbean was performed by Cawich *et al*[13] on November 29, 2021. This was greeted with resistance from established laparoscopic surgeons who touted that this would prolong operation times, increase complication rates and compromise oncologic standards. Therefore, this pilot study sought to compare the initial results between conventional and FreeHand robot-assisted laparoscopic colectomy in Trinidad and Tobago. The primary outcomes of this pilot study were to compare total operating times, number of conversions to open surgery and conversions to a human camera person. The secondary endpoints were to compare post-operative outcomes: Total duration of hospitalization, post-operative morbidity and oncologic standards (node harvest, resection margins) between the techniques.

MATERIALS AND METHODS

In this study an independent researcher observed all laparoscopic colectomies performed in patients who had confirmed diagnoses of colorectal carcinoma over a six-month period from November 29, 2021 to May 30, 2022. This was an observational study and no change in treatment protocols were required for the purposes of this study. The attending surgeon decided which patients would be offered conventional laparoscopy or resections using the Freehand® (Freehand 2010 Ltd., Guildford, Surrey, United Kingdom) robotic camera holder, many times based on availability of the robot. When the robot was utilized, the attending surgeon solely made the decision on setup of the operating room and positioning of the robot.

The study was approved by the local institutional review board, and each patient gave their consent to have an observer present in order to be included in the study. We only included patients who had operations performed by attending surgeons and those who had operations for colorectal malignancies. We excluded patients below the age of 18, those who had rectal operations, other procedures at the same sitting, emergent operations and those who did not consent to participate.

The independent observer recorded the following data: Robot docking time (time for draping, lens fixation and positioning), total operating time (time from first skin incision to closure of last incision inclusive of robot docking time), conversions to open surgery, conversions to a human camera operator, estimated blood loss and intra-operative complications. After discharge, all patient records were retrieved for detailed analysis and the following data extracted: Total duration of hospitalization, post-operative complications and mortality.

Histopathologic data were also collected since a secondary outcome of this study was to compare oncologic standards. Current guidelines[14-28] stipulate that an oncologically adequate surgical procedure is a curative colectomy with complete removal of the cancer bearing segment of colon[14-17], resection margins ≥ 10 cm from the primary[14,18,19] and ≥ 12 regional lymph nodes[14,20-28]. Therefore, a colectomy was only considered oncologically adequate in our study if there were resection margins ≥ 10 cm and ≥ 12 nodes harvested in the specimen.

All data were entered into an excel database and the data were compared using SPSS 20.0. Continuous variables were compared using the Mann-Whiney test and Fisher's exact test was used to compare categorical data. A $P < 0.05$ was considered significant.

RESULTS

Over the study period, data were collected from 23 patients undergoing laparoscopic colectomies for malignant disease. Eight (35%) patients underwent robot assisted colectomies and 15 (65%) had conventional laparoscopic colectomies. All procedures were performed by attending surgeons with significant experience in laparoscopic colectomies. There were no conversions to open surgery in this cohort.

The conventional laparoscopy group (15) was comprised of 8 (53%) men and 7 (47%) women at an age of 57.9 ± 8.43 years (mean ± SD). In this group, the procedures were right (6), left (2) and sigmoid colectomies (7).

In the robot group (8), there were 5 (63%) males and 3 (37%) females at an age of 59.9 ± 6.90 years (mean ± SD). In this group, the procedures were right (5), left (1) and sigmoid colectomies (2). The robot docking time was 5.9 ± 1.25 min (mean ± SD). No conversions to a human camera holder were recorded.

Overall, there was no mortality and only one (4%) patient experienced a superficial surgical site infection requiring opening of the wound and therapeutic antibiotics. The outcomes in both groups are compared in Table 1. The only parameter that achieved statistical significance was the total operating time, which was shorter in the robot-assisted colectomy group (95 min *vs* 105 min; $P = 0.0455$).

DISCUSSION

Open surgeons resisted the introduction of laparoscopic resections for colorectal carcinoma in the Anglophone Caribbean [11], similar to the experience reported across the globe. Now that laparoscopic colectomy has become widely accepted, we have witnessed conventional laparoscopic surgeons mounting aggressive resistance to single incision laparoscopic[12] and robot-assisted laparoscopic[13] colectomy. Specifically, conventional laparoscopic surgeons in the Caribbean suggested that operators would be distracted by the robotic controls and this would lead to increased complication rates, prolonged operating times and compromised oncologic standards. Often, established surgeons have gained sufficient reputation that their utterances are often believed, despite the lack of supporting evidence or data. Therefore, we carried out this study to provide objective data for evidence-based decisions.

We have shown that use of the FreeHand® robot does not increase blood loss, morbidity or mortality, when compared to conventional laparoscopy. Additionally, oncologic standards are not compromised as there were equivalent resection margins and adequate nodal harvest. In fact, post-operative morbidity, mortality and hospitalization recorded in this study were comparable to published data on laparoscopic colectomies from the Anglophone Caribbean[9,11,29].

In this study, only one parameter attained statistical significance – the mean total operating time was 10 min shorter when the FreeHand® robot was utilized. Interestingly, this was also shorter than the mean time to perform a conventional laparoscopic colectomy in Caribbean literature[9,11,29] that was reported to span from a minimum of 150 min[9] to a maximum of 175 min[29]. We theorized that the surgeon's ability to control vision and reduced communication time between the camera person and the surgeon may have contributed to this effect. This was well-stated by Ballantyne *et al* [30] who wrote: "*inexperienced or bored camera-holders move the camera frequently and rotate it away from the horizon.*" We suggest that a distinct advantage of this technology is the surgeon having full control of their vision.

This robot had one arm that held the scope in response to directions from the surgeon using an infrared communicator. More sophisticated platforms such as the DaVinci (Intuitive Surgical Inc, Sunnyvale, California, United States) robots have additional operating arms to facilitate specialized instruments and increased functionality[31-34], but these would come at significantly greater cost. Most Caribbean nations could not afford these advanced systems as most were low and middle income countries[13]. Up to this time of publication, there were no DaVinci platforms in any nation in the Anglophone Caribbean. Nevertheless, the FreeHand® robot balanced cost while providing some advantages over conventional minimally invasive surgery.

Since we only evaluated short-term outcomes, we cannot comment on long-term outcomes, but we anticipate that they would be similar to those from conventional minimally invasive colectomy, that is supported by good quality data[1-8, 35].

Table 1 Comparison of patients undergoing laparoscopic colectomy for colorectal carcinoma (mean SD)

Parameter	Conventional	Robot	*P* value
Robot docking time in minutes	-	5.9 ± 1.25	-
Total operating time in minutes	105.67 ± 11.48	95.13 ± 9.22	0.0455[a]
Conversions to open surgery (*n*)	0	0	-
Conversions to human camera operator	-	0	-
Estimated blood loss in mL	62 ± 27.89	96.25 ± 93.80	0.71884
Number of nodes harvested	13 ± 2.24	13.13 ± 2.70	1
Proximal resection margin in cm	20.5 ± 5.78	20.75 ± 7.11	0.95216
Distal resection margin in cm	18.87 ± 6.71	16.88 ± 3.48	0.69654
Duration of hospitalization in days	3.73 ± 0.88	3.13 ± 1.36	0.12852
Post-operative major morbidity	0	0	1
Post-operative minor morbidity	1	0	1
Mortality	0	0	-

[a]$P < 0.05$.

This study had few limitations: Firstly, it evaluated outcomes when colectomies were performed by experienced laparoscopic surgeons who were beyond their learning curves for laparoscopic colectomies. Therefore, these results may not be extrapolated to those by community surgeons.

Secondly, the case numbers were small in this pilot study, reducing the power of our observations. This was largely based on the availability of cases/equipment in this resource poor region.

Finally, the cases chosen for robot-assisted colectomy were not blinded. Case selections were made solely by the attending surgeons, and this may have introduced selection bias.

CONCLUSION

Using this technology to complete colectomy is safe and does not compromise oncologic standards in the resource-poor Caribbean setting.

ARTICLE HIGHLIGHTS

Research background

There is limited experience with robotics in surgery in the English-speaking Caribbean, although the laparoscopic approach to colorectal surgery is widely accepted for colorectal cancer. We recount our experience since the FreeHand robotic camera holder was introduced to the Caribbean in 2021.

Research motivation

In the English-speaking Caribbean, we experienced resistance to the introduction of the FreeHand® robotic camera holder to augment laparoscopic colorectal surgery. Therefore, we attempted to collect data to compare the initial results between conventional and FreeHand® robot-assisted laparoscopic colectomy in Trinidad and Tobago.

Research objectives

The aim of this study was to collect objective outcome data to compare robot-assisted and conventional laparoscopic colorectal resections for malignancy. The objectives were achieved and show that there is some advantage that requires further research in the future.

Research methods

A prospective study was carried out to collect data on the outcomes from all laparoscopic colectomies performed for colorectal carcinoma over a six-month period in Trinidad and Tobago. An independent observer recorded operating times, conversions, estimated blood loss, hospitalization, morbidity, surgical resection margins and number of nodes harvested. SPSS version 20 was used to analyze all data.

Research results

Of 23 colectomies performed for malignant disease, 8 (35%) were performed with the FreeHand® robot and 15 (65%) by conventional laparoscopy. There were no conversions. Operating time was significantly lower in patients undergoing robot-assisted laparoscopic colectomy (95.13 ± 9.22 *vs* 105.67 ± 11.48 min; P = 0.045). Otherwise, there was no difference in estimated blood loss, nodal harvest, hospitalization, morbidity or mortality.

Research conclusions

We have demonstrated that the FreeHand® robot for colectomies is safe, provides some advantages over conventional laparoscopy and does not compromise oncologic standards.

Research perspectives

This preliminary study suggests that operating time can significantly be reduced with the use of the FreeHand robot. This will guide future research. If larger studies confirm this finding, there will be significant implications for cost-savings in this setting. This will have significant positive implications for use of technology in low and middle income nations.

FOOTNOTES

Author contributions: Cawich SO conceptualized the research project, wrote the paper and checked for scientific accuracy; Plummer JM collected data and checked the manuscript for scientific accuracy; Griffith S collected data, performed statistical analyses and checked the manuscript for scientific accuracy; Naraynsingh V collected data, performed statistical analyses and checked the manuscript for scientific accuracy.

Institutional review board statement: This study was approved by the local institutional review board at the University of the West Indies (CREC-SA.1615/06/2022). A copy of the approval document will be provided upon request.

Informed consent statement: All study participants or their legal guardian provided informed written consent about personal and medical data collection prior to study enrolment.

Conflict-of-interest statement: There are no conflicts of interest for any of the authors of this study.

Data sharing statement: All data are kept by the corresponding author and can be released upon reasonable request.

STROBE statement: The authors have read the STROBE Statement—checklist of items, and the manuscript was prepared and revised according to the STROBE Statement—checklist of items.

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