Original Article

The value and the future of CT colonography, the emerge of highly competitive diagnostic modality

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Background: CT colonography (CTC) is known as a virtual colonoscopy is a non-invasive procedure in assessing large bowel disease. It has a valuable potential to provide extra colonic diagnosis.

The aim of this study is to assess the value of CTC in a group of patients who had incomplete colonoscopy, and determine the potential of CTC as the modality of choice in this group.

Methods: A retrospective study of 469 patients had CTC between January 2015 and December 2015. Analysis of the data revealed 259 had CTC without colonoscopy, 52 had a double request of CTC and colonoscopy, 158 had CTC following failed colonoscopy. Fifty-six patients of 158 were excluded from the study due to poor bowel preparation, and had failed flexible sigmoidoscopy. The reports of 102 patients were retrieved and assessed. Measured data included: age, sex, indication, type of sedation, hysterectomy history, abdominal surgery abdominal pain, and diverticulosis.

Results: Eighty-four (82.3%) female, 18 (17.6%) males with median ages 65.5 (range, 25–94), and 66 (range, 32–83) respectively. The main cause of failure was pain and unresolved loop. In 79 patients (77.4%), risk factors for incompletion were identified. Twenty-two had abdominal pain, 12 had a long midline scar, 4 had laparoscopic surgery, 11 had severe diverticular disease, 26 had hysterectomy, 2 had a bulky pelvic uterus and 2 patients were deemed too frail to have colonoscopy. In all 102 patients, CTC was completed and offered diagnosis at no risk.

Conclusions: CTC proved to be the modality of choice in high-risk patients for incomplete colonoscopy, shedding the light on the future of CTC as the first line investigation in this group.

Keywords: Incomplete colonoscopy; CT colonography (CTC); risk factors colonoscopy; perforation

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Introduction

Colorectal cancer is one of the most common cancers in the western hemisphere, ranking third after lung and breast cancer worldwide with an increased incidence with age; median age at diagnosis is about 70 (1,2).

Increasing awareness of colorectal cancer and developing rapid access service to investigate symptoms, has mounted the demand on colonoscopy as a first line investigation. Consequently, there has been an increase in pressure on colonoscopy units, schedulers and on endoscopists to achieve the targeted high completion rate of 90% and above (3-5).

Through observation of our practice the colonoscopy request form has all information related to: risk of infection, renal function, anti-coagulants and other safety precautions. However, there is no reference to the risk factors of a

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challenging colonoscopy or predictive factors of incomplete colonoscopy, such as abdominal surgery, pelvic surgery and hysterectomy (6-9).

As it is essential to achieve over 90% success rate for completion of colonoscopy and to reduce the pressure on waiting lists, it is equally vital for endoscopists to maintain these figures in order to maintain their competency. However, this maintenance of competency and success rate will be challenged by difficult colonoscopies. This conflict of interest on completion may have adverse effects on patient's safety, and patient's satisfaction. In addition, failure of colonoscopy may add more financial pressure and strain to the system by further delays and requirements for repeat conventional colonoscopy, colonoscopy under general anesthesia or even a request for CTC.

On the other hand, availability of CTC—a minimally invasive imaging technique—in investigating colorectal cancer may be considered as an alternative modality in a high-risk group, due to its growing success in screening, surveillance, detecting polyps and extra-colonic findings (10-15).

Furthermore, CT colonography has been proven to be a safe and minimally invasive imaging technique, a valuable diagnostic tool for examining the entire colon and a good alternative compared to other colorectal cancer screening tests. Devir *et al.* (16) compared CT colonography and conventional colonoscopy in detecting colorectal lesions, and found high sensitivity values in colorectal lesions over 1 cm. CTC showed 83% sensitivity and 95% specificity, with a positive predictive value of 95% and a negative predictive value of 83% for the detection of colorectal polyps and masses.

Therefore, our aims in this study are to assess the value of CTC against the conventional colonoscopy in a group of patients who had incomplete colonoscopy, to determine the potential of considering CTC as an alternative to colonoscopy in this group.

We present the following article in accordance with the STARD reporting checklist (available at http://dx.doi.org/10.21037/dmr-20-22).

Methods

A retrospective study was carried out, collecting radiological data of 469 patients who underwent CTC between January 2015 and December 2015. All data was retrieved from the radiology department at Diana Princess of Wales Hospital through computer-based records. This is including colonoscopy reports for comparison. All reports of CTC, colonoscopy including the referral forms were reviewed and analysed accordingly. The data was analyzed and revealed 469 had CTC: for 259, the primary request to investigate bowel symptoms was CTC; 158 had CTC due to a failed colonoscopy and the remaining 52 had CTC and colonoscopy requested, but no sufficient data to suggest why patients had both tests and therefore excluded.

One hundred and fifty-eight patient endoscopy reports were reviewed: 56 patients were excluded from the study as colonoscopy was abandoned due to poor bowel preparation, and had flexible sigmoidoscopy on the primary request. CTC imaging reports of 102 patients were extracted and colonoscopy reports of these patients were assessed. Measured data included: age, sex, indication, types of sedation, history of hysterectomy, abdominal surgery and abdominal pain. CTC reports were analyzed against the incomplete colonoscopy to determine any risk factors or pathological causes attributed to incomplete colonoscopy. The study was conducted in accordance with the declaration Helsinki (as revised in 2013).

Statistical analysis

Descriptive statistics were used in this study through SPSS in analysing quantitative categorical data.

Results

In the studied group of 102 patients, the main indication for colonoscopy was changing bowel habit followed by positive fecal occult blood and anaemia (*Figure 1*). Thirty-four percent of patients had Entonox and 66% had awake sedation of mixed fentanyl and Midazolam.

The number of females was considerably higher than that of males: 82.3% female [84] compared to just 17.6% male [18] with P value <0.001. Female median age was 65.5 (range, 25–94) compared to male median age which was 66 (range, 32–83) with no statistical difference P value 0.29 (*Table 1*).

The procedure had to be stopped for 81 patients (79.4%) due to pain, 16 (15.6%) due to looping, 4 (3.9%) due to acute bend and one patient had persistent bradycardia therefore procedure abandoned (*Figure 2*).

Sigmoid colon was the most common site for failure 65 (63.7%) followed by the splenic flexure 16 (15.7%), transverse colon 10 (10%), hepatic flexure 9 (9%) and 2 (2%) failed to intubate the cecum (*Figure 3*).

All patients who had incomplete colonoscopy had CTC completed.

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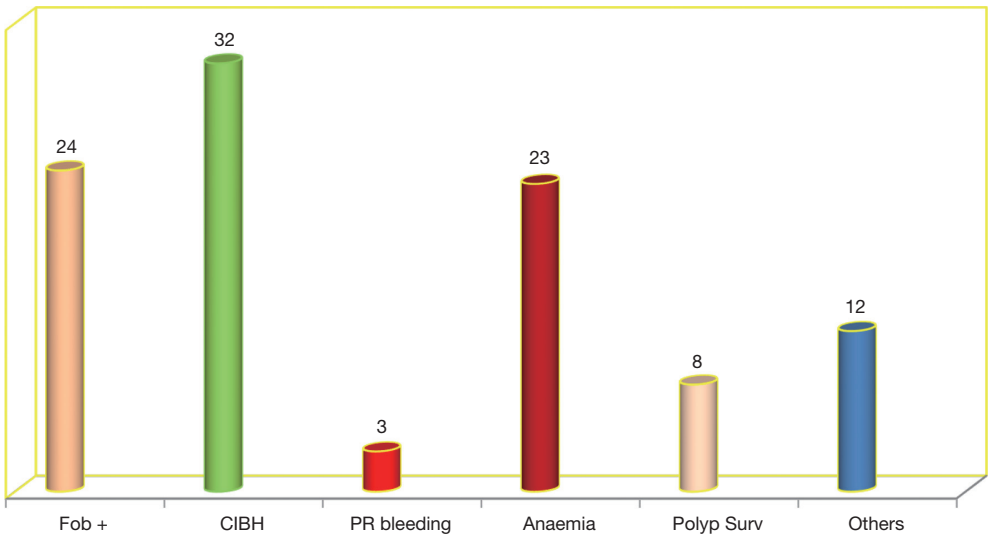

Figure 1 Indications for colonoscopy.

Table 1 Male *vs.* female

	Male	Female	P value
Age (median)	66 [32–83]	65.5 [25–94]	0.29
No	18	84	<0.001

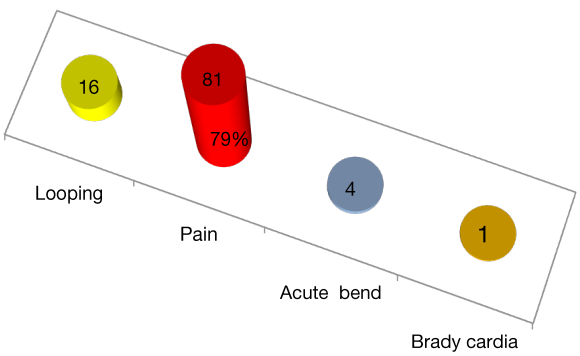

Figure 2 Causes of incomplete colonoscopy.

In 58 (57%) CTC was normal, 36 (35%) diverticulosis, 6 (6%) polyps, 2 in rectum size 4 and 5 mm; 3 in sigmoid size 4, 6, 6 mm and 1 in cecum of 4 m. There were 2 strictures in sigmoid colon deemed impassable (*Figure 4*).

CTC showed incidentally 10 pathology, 4 (4%) of clinical significance required further investigation and this included lymphoma, benign adrenal tumour, indeterminate lesion in the lung required follow up scan and benign pancreatic cyst (*Figure 5*).

In 79 patients, 77.4% risks factors for incompletion were identified. Twenty-six had hysterectomy, and 2 had bulky pelvic uterus, 22 (21.5%) abdominal pain/IBS, 12 (11.8%) patients had open abdominal surgery with midline incision, 11 (10.8%) had severe diverticula disease, 4 (3.9%) laparoscopic surgery and 2 (1.9%) patients deemed frail to have colonoscopy (*Table 2*). In all failed patients CTC was completed and offered diagnosis at no risk.

Discussion

Colonoscopy is widely used in investigating and screening colorectal cancer: one of the most common cancer affecting male and female worldwide (17-21).

It has the diagnostic and therapeutic advantage ranking colonoscopy as one of the most popular tools in its current era with an estimated 14.2 million colonoscopies performed in 2002 (22).

However, the risk of perforation, which could range between 0.019% to 0.8% of diagnostic and 0.10% to 3% of therapeutic, has always been of an interest to many researchers in spite of the remarkable success of

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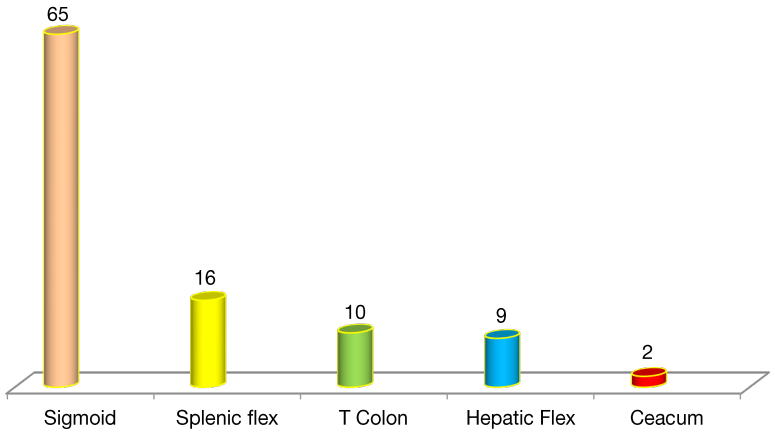

Figure 3 Failed sites.

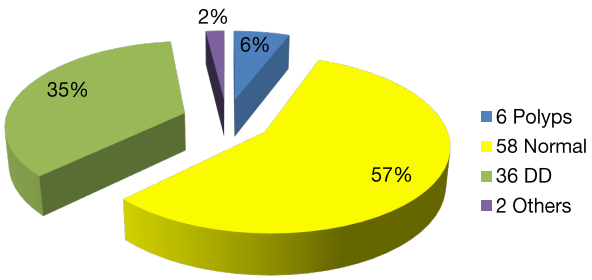

Figure 4 CT colonography (CTC): intra-colonic findings.

colonoscopy (23). This interest is mainly triggered by the associated risk of mortality and morbidity as a third of patients may require stomas (24).

Dedicated research over the last decade disclosed risk factors leading to adverse events in colonoscopy (25-28).

Perforation continued to be a great concern in colonoscopy with its impact on patients and the health system. Therefore, understanding of the mechanisms and disclosure of the risk factors of perforation in colonoscopy may prevent serious consequences. This was highlighted in Rai *et al.* (29) 2018 published paper, appreciating the value of colonoscopy in reducing the number of colorectal cancer whilst declaring colonic perforation as a serious complication with high morbidity and mortality. The incidence of perforation will only continue to rise as the number of colonoscopies performed increases.

Without a universal and agreed protocol on a selective colonoscopy in a high-risk group, colonoscopy will continue to be a challenging procedure to patients and endoscopists.

In our study, 79 (77.4%) of those who failed colonoscopy had associated risk factors for incompletion. Two patients (aged 93 and 83) were deemed unsuitable for colonoscopy due to frailty and poor mobility on the day of the procedure. CTC was arranged as an alternative and diverticular disease was confirmed in both patients as the cause of symptoms.

Ageing is of a concern when it comes to colonoscopy. Several studies investigated risk factors for iatrogenic perforations during colonoscopy. In a retrospective analysis of risk factors using the clinical outcomes Research Initiative National Endoscopic Database, Bielawska *et al.* (30) found age greater than 75 years, is one of the risk factors significantly associated with increased risk of early perforation.

Regardless of the associated co morbidity, elderly patients have limited physiological and physical reserves to undergo a procedure that sometimes could be very challenging. Most importantly, their ability to stand complications is low. On the other hand, full cooperation and following commands during the procedure proved to be another major challenge to elderly patients and endoscopists.

Although the median range of patient's age in our study was 65, aging has always been of concern in particular with the increasing demand on colonoscopy and the increasing number of elderly patients attending for colonoscopy. This was demonstrated in Kim *et al.* (31) in this recently published article in 2019, there has been a concern regarding the increased morbidity and mortality related colonoscopy by increasing number of elderly patients attending for the test.

Furthermore, in Day *et al.* (32) a systematic review and meta-analysis of adverse events in older patients undergoing colonoscopy showed adverse events and complications will not be tolerated in this group, in particular with limited

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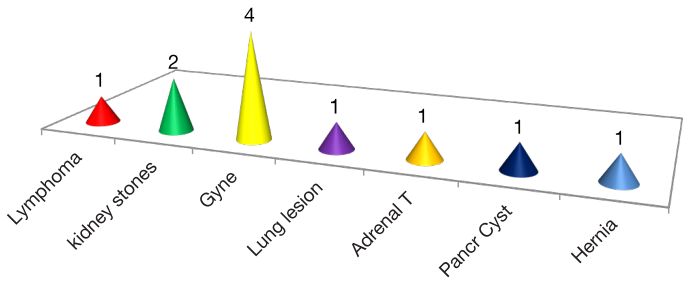

Figure 5 CT colonography (CTC): extra-colonic findings.

Table 2 Risk factors for incomplete colonoscopy

Risk factors	No
Hysterectomy	26
Bulky uterus	2
Abdominal surgery	12
Laparoscopic surgery	4
IBS	22
DD	11
Others	2

physical and functional reserves to cope with complications, hence morbidity is high.

Nevertheless, predicting incomplete colonoscopy and displaying risk factors contributing to incomplete colonoscopy were disclosed and linked to the presence of abdominal surgery and complicated diverticular disease. In Cirocco *et al.* (33), a 1995 study on 1,047 patients concluded women, especially those with a history of abdominal hysterectomy, had a significantly lower caecal intubation rate, usually because of failure to pass through the sigmoid colon.

In our study, 31% of females [26] had hysterectomy and 1.9% [2] had large uterus. In 18 patients with hysterectomy (69%) the failure was in the sigmoid and similarly colonoscopy was abandoned in the sigmoid in the 2 patients with a bulky uterus. This may reflect a fact that changes in pelvic anatomy predispose endoscopists to a challenging procedure, due to the close anatomical relations between the most difficult part to navigate through (sigmoid) and the surroundings in the pelvis.

Binding the fact of a challenging sigmoid in this group and a higher rate of perforation in sigmoid (34), there is no safeguard protocol to consider an alternative as a first-choice modality in this group.

The argument therefore, is that many patients with hysterectomy and pelvic surgery had colonoscopy completed, but at a higher probability of mortality and morbidity, with pain, higher sedative dose, longer procedure time and poor experience.

The challenge in colonoscopy is not restricted to one risk factor and it is evident that patients with abdominal surgery are also at risk during colonoscopy. In Shah *et al.* (35), factors associated with incomplete colonoscopy were: elderly, female, past abdominal surgery and pelvic surgery. These findings are observed in our group of 102, where 16 patients had abdominal surgery, 12 (11.8%) with midline incision and 4 (3.9%) had laparoscopic surgery. These findings encouraged the authors to support that alterations in abdominal anatomy contributes to failed colonoscopies and unsatisfactory experience for both patients and endoscopists. Such observations may favor CTC as a first line option in this group, unless colonoscopy is recommended for highly suspected pathology or requested for polypectomy.

In Hanson *et al.* (36), the study looked into anatomical variation of the colon and its impact on incomplete colonoscopy. One hundred patients had CTC after incomplete colonoscopy compared with a control group who had complete colonoscopy after CTC. The study showed significant statistical difference between the complete and incomplete colonoscopy groups in terms of history of abdominal surgery (26.0% *vs.* 48.0%; P<0.01), advanced diverticular disease (22.0% *vs.* 34.0%; P<0.05) and the length of colon. Total colorectal length in the incomplete group was longer than the complete group (mean, 167.0 *vs.* 210.8 cm; P<0.0001), and the difference was noted in the different segment of the colon; in the sigmoid, colon length was longer in the incomplete group than the complete group (mean, 48.7 *vs.* 66.8 cm; P<0.0001), transverse colon length (mean,

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49.2 *vs.* 66.3 cm; P<0.0001), number of flexures (mean, 9.6 *vs.* 11.9; P<0.0001).

In Dafnis *et al.* (37), the study demonstrated, presence of diverticulosis had an impact on failed colonoscopy.

In our study, 11 (10.8%) had severe diverticular disease; the procedure had to stop in the sigmoid and this repeatedly demonstrates that variations in sigmoid anatomy and presence of different pathology are strong indicators of ability to complete colonoscopy. Prior knowledge of such variation may prove to be necessary to consider alternative options. Nevertheless, this group underwent uneventful CTC as an alternative at no risk.

In summary, our study disclosed the risk factors for incomplete colonoscopy and its implications on patients, services and endoscopist. Colonoscopy in the identified high-risk group could be extremely challenging to endoscopists, and may expose patients to a higher rate of morbidity and mortality as compared to its rival CTC.

CTC, in our study, proved to be an alternative diagnostic procedure to colonoscopy in this group. Therefore, a universal safeguard protocol considering CTC as an alternative first line investigation may need to be addressed in the future, to avoid colonoscopy in the high-risk group for incomplete colonoscopy and its unwanted consequences.

Conclusions

Colonoscopy is a challenging procedure in high-risk patients for incomplete colonoscopy in the presence of CTC a successful and a safe diagnostic imaging alternative. This study sheds the light on the future of CTC as a first line modality in this group.

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Footnote

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Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. No procedures performed in our studies involving patients. Informed consent was not required. The data was collected for internal audit for improvement and quality assurance. No statement from patients are required or consent.

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