

## **CT Colonography, the Revolutionary Imaging Tool in Detecting Colon Cancer and Extra Colonic Conditions, a Comparative Study with the Gold Standard Colonoscopy**

**George Bazoua<sup>1\*</sup>, Joseph Alex<sup>2</sup>, Deepak Pai<sup>2</sup>, Mohammad Abdi<sup>3</sup> and Hussein Hassan<sup>2</sup>**

<sup>1</sup>Consultant General Surgeon with Interest in Colorectal Surgery, Department of General and Colorectal Surgery, Northern Lincolnshire and Goole NHS Foundation Trust, Diana Princess of Wales Hospital, Grimsby, England, UK

<sup>2</sup>Consultant Radiologist, Department of Radiology, Northern Lincolnshire and Goole NHS Foundation Trust, Diana Princess of Wales Hospital, Grimsby, England, UK

<sup>3</sup>Radiology Trainees, Department of Radiology, Northern Lincolnshire and Goole NHS Foundation Trust, Diana Princess of Wales Hospital, Grimsby, England, UK

**\*Corresponding Author:** George Bazoua, Consultant General Surgeon with Interest in Colorectal Surgery, Department of General and Colorectal Surgery, Northern Lincolnshire and Goole NHS Foundation Trust, Diana Princess of Wales Hospital, Grimsby, England, UK.

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### **Abstract**

**Background:** CT Colonography (CTC) has equivalent sensitivity and specificity to colonoscopy, provided it is performed to internationally agreed standards. It is essential to assess the quality of (CTC) service provision against these standards.

**Aim:** Evaluate the diagnostic performance of (CTC) in detecting colorectal cancer and polyps using conventional colonoscopy (CC) as the gold standard technique. Assess the sensitivity, specificity, positive and negative predictive value of CTC versus CC in each group and overall.

**Methods:** Retrospective review of 547 patients referred for (CTC) with colorectal symptoms between January 2013 to December 2013. 467 (85.4%) had (CTC) and 80 (14.6%) had (CTC) and colonoscopy. Colonoscopy and (CTC) findings were compared. Patients with negative (CTC) for cancer followed up in Somerset cancer register for 3.5 years.

**Results:** Gender distribution showed 42% males Vs 58% females with 511 (93.4%) good colonic distention compared to 36 (6.6%) poor distention. (CTC) was normal in 357 (65%), extra-colonic pathology noncancerous in 67 (12.2%), polyp detected in 54 (9.8%), failed (CTC) in 36 (6.5%), colorectal cancer found in 21 patients (3%), extra-colonic cancer in 7 (1.2%), severe diverticulitis in 5 patients (0.9%). Positive predictive value (PPV) was 97.4%, Negative predictive value (NPV) was 95.2%, Sensitivity 94.9%, Specificity and 97.6%. Findings matches Somerset cancer registry in 2017 with no cancer detected in those patients with normal (CTC).

**Conclusion:** (CTC) is a reliable minimally invasive imaging tool as compared to colonoscopy in detecting colonic polyps and cancer with additional benefits of detecting extra-colonic conditions.

**Keywords:** Screening CT Colonography; Colorectal Cancer; CTC vs Colonoscopy

## Introduction

Over 2 decades CT Colonography (CTC) continues to evolve as a revolutionary imaging technology in investigating large bowel pathology and consider one of the leading investigator in colorectal cancer [1]. That success was not limited to investigating large bowel pathology but as well for diagnostic value in extra-colonic pathology mounting the success and encouragement to explore further the power of CTC in investigating colorectal cancer and polyps as compared to colonoscopy [2].

Further research emerged over the last decade and strongly correlated the high sensitivity of (CTC) of 90% in detecting colorectal adenomas  $\geq 6$  mm, equal to the conventional colonoscopy in investigating colorectal cancer [3].

(CTC) continued to evolve and deemed essential to be considered in core surgical training in the UK and part of the radiology training curriculum which has increased confidence in reporting (CTC) [4].

All progress followed with further studies demonstrated (CTC) of  $> 75\%$  sensitivity and  $> 95\%$  specificity for detecting polyps greater than 1 cm in size [5,6].

During routine normal working practice within teaching hospital and good centres, a sensitivity of 89% and specificity of 94% has been reported for polyps larger than 5 mm in size [7].

As (CTC) has proved a competitive modality in quality of sensitivity and specificity to the standard colonoscopy in investigating large bowel pathology, local assessment of the quality of (CTC) service provision against the standard was carried out in our institution.

## Methods

Retrospectively evaluate the diagnostic performance of Computed Tomographic Colonography (CTC) for the detection of colorectal cancer and polyps against conventional colonoscopy (CC) as the gold standard technique.

The study conducted a retrospective review of 547 patients referred to the radiology department for (CTC) with colorectal symptoms between January 2013 and December 2013. During 12 months period 467 patients (85.4%) attended for CTC and 80 patients (14.6%) had colonoscopy and CTC.

The data collection followed audit protocol in the radiology department retrieving computerised saved data of (CTC) request forms, (CTC) and colonoscopy reports. The measured data includes indication, Age, gender, diagnostic findings. All data were gathered and subjected to series of comparison between (CTC) and colonoscopy looking into final outcomes assessing sensitivity, specificity, positive and negative predictive value of (CTC) versus (CC) in each group and overall. Descriptive statistics through SPSS in analysing quantitative categorical data were carried out and patients with negative (CTC) were followed up in Somerset cancer register if developed colorectal cancer within 3.5 years from the initial (CTC).

## Results

In a busy district hospital there has been an increasing demand on using (CTC) to assess patients with colorectal presentations in particular frail and elderly. The audit revealed 547 patients had attended for CTC with Gender distribution of 42% males Vs 58% females (Figure 1). 467 (85%) had CTC and 80 patient (14.6%) underwent a combined procedure CTC and colonoscopy (Figure 2).

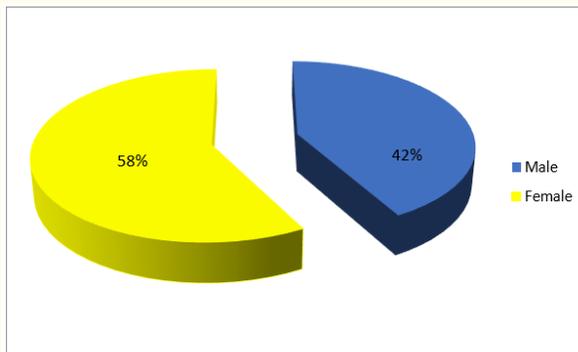


Figure 1: Gender distribution.

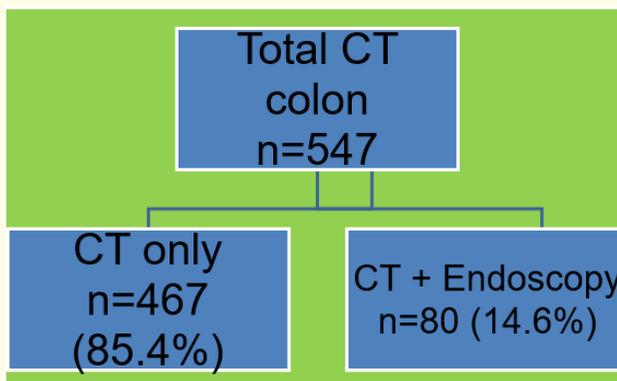


Figure 2: Total number of patients investigated with (CTC) and colonoscopy.

Referral from surgery contributed to (73.5 %) 402 patients of total referral compared to (20%) 110 patients from medicine and (6.5%) 35 patients from general practitioners (Figure 3).

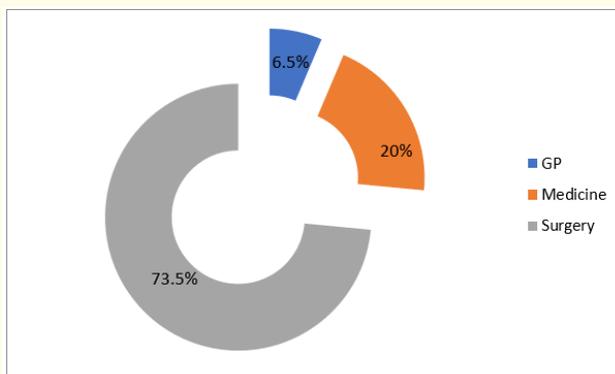
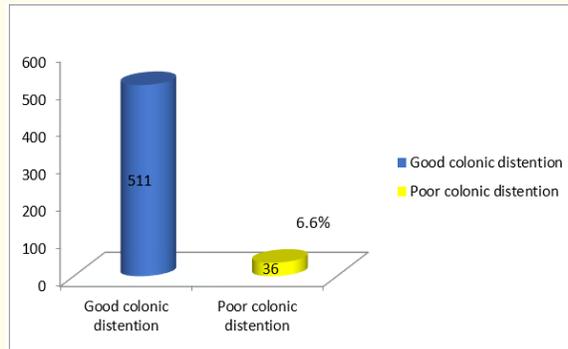


Figure 3: Source of referrals.

511 (93.4%) had good colonic distention compared to 36 (6.6%) poor distention, however this did not limit visibility with satisfactory results (Figure 4).



**Figure 4:** Variations in colonic distention (CTC).

In 357 (65%) CTC was normal, extra-colonic pathology noncancerous in 67 (12.2%), polyp detected in 54 (9.8%), poor distention in 36 (6.5%), colorectal cancer found in 21 patients (3%), extra-colonic cancer in 7 (1.2%), severe diverticulitis in 5 patients (0.9%) (Table 1).

Findings	N	%
Normal	357	65.2
Polyp	54	9.8
Cancer	21	3
Severe diverticula	5	0.9
Extra colonic (other)	67	12.2
Extra colonic (cancer)	7	1.2
Poor distention	36	6.6

**Table 1:** Overall findings of (CTC).

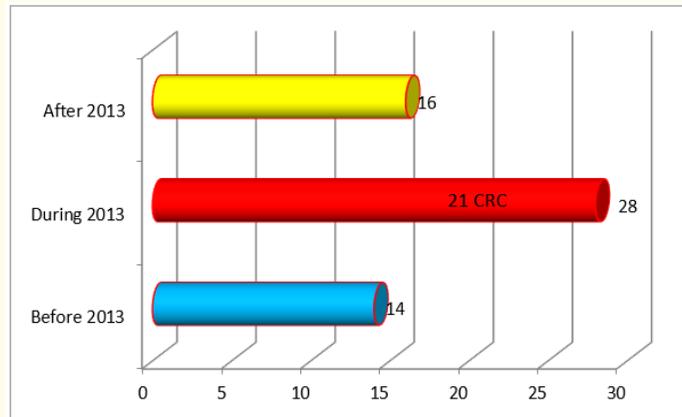
Further analysis of 80 patients who had both procedures, comparing CTC to colonoscopy findings, the data revealed 37 patient had true positive (TP) and 2 patients had false negative (FN) producing sensitivity of 94.9% table 3, on the other hand 40 patients had true negative findings (TN) compared to 1 patient had false positive (FP) producing specificity of 97.6% (Table 2).

True Positive (TP) 37	False Negative (FN) 2	Sensitivity = TP / (TP + FN) 37/39 = 94.9%
False Positive (FP) 1	True Negative (TN) 40	Specificity = TN / (TN + FP) 40/41 = 97.6%
Positive Predictive Value (PPV) = TP / (TP + FP) 37/38 = 97.4%	Negative Predictive Value (NPV) = TN / (TN + FN) 40/42 = 95.2%	

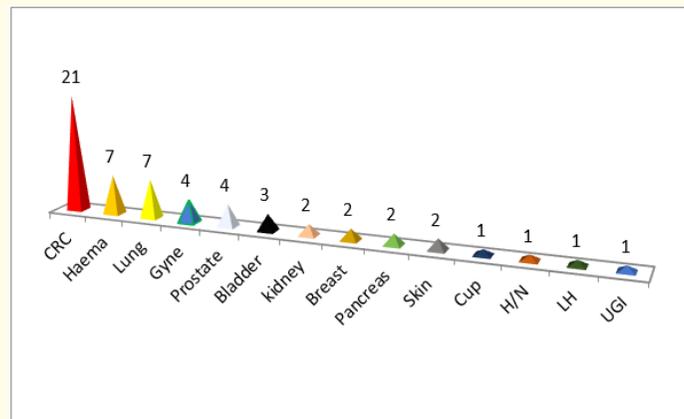
**Table 2:** CT colonography vs conventional colonoscopy.

Results accordingly showed Positive predictive value (PPV) was 97.4% compared to Negative predictive value (NPV) of 95.2%.

Somerset registry was followed up for 3.5 years to assess if any patients who had negative (CTC) developed colorectal cancer. Total number of patient who had cancer was 58 (Figure 5) outside our group 14 cancers were filed at Somerset before 2013 with 28 cancers (21 CRC and 7 extra colonic) during 2013 representing our registered patients who had CRC and extra-colonic cancer on (CTC). 16 extra-colonic cancers registered in our group, with majority lungs and haematology with no record of colonic cancer detected after 2013 over 3.5 years (Figure 6). Findings matches Somerset cancer registry in 2017 with a conclusion no colonic cancer detected in our group with normal (CTC) through the interval period of 3.5 years.



**Figure 5:** Somerset cancer register total no: 58.



**Figure 6:** Findings in Somerset cancer register. (Cup, cancer unknown primary); (H/N, Head and Neck cancer); (LH, Langerhans Histiocytosis).

## Discussion

According to cancer research UK (2016-2018) 42,900 new cases of colorectal cancer were diagnosed every year equivalent to 120 every day. It is 3<sup>rd</sup> most common cancer in male and females in the UK with highest incidence in people aged 85 to 89.

Such data encouraged researchers throughout the years to search for varieties of modalities of high sensitivity and specificity in early detection and prevention of bowel cancer. It was clear that early detection of bowel cancer depends on early detection and removal of adenomatous polyps with a historical role of colonoscopy and the new role of emerging non-invasive alternative technology (CTC).

With the increasing popularities of (CTC) over the last 20 years as an alternative safe modalities to colonoscopy in investigating colorectal cancer more roles started to resurface including the engagement of (CTC) in screening programmes. A series of studies explored the state of (CTC) in screening colorectal cancer [8-13].

In 2016 Sali, *et al.* [8] title of "CT colonography for population screening of colorectal cancer: hints from European trial". In this European randomized controlled trials they looked into the role of (CTC) as a screening tools of (CRC) in comparison with faecal immunochemical test (FIT), sigmoidoscopy and colonoscopy. (CTC) proved to have a higher rate of detecting colorectal cancer and advanced adenoma as compared to FIT test and sigmoidoscopy but lower than colonoscopy. However, due to higher participation rate in (CTC) screening as compared to colonoscopy screening, the detection rates per invitee of (CTC) and colonoscopy appeared to be similar with a conclusion of future engagement of (CTC) in screening (CRC).

2 years later in Obaro, *et al.* [9], the thorough evaluation of the role of (CTC) as a non-invasive and screening test were highlighted in his study "a Colon cancer screening with CT colonography: logistics, cost-effectiveness, efficiency and progress" with a conclusion from 3 large scale European trials supporting the reliability of (CTC) in population screening.

The popularity of (CTC) was evident in our institute with 547 patients attended for this procedure over a period of 12 month investigating large bowel symptoms including varieties of presentations, such as rectal bleeding, changing bowel habits, anaemia and weight loss. The majority 467 (85%) had (CTC) only and 80 patients had both procedures (14.6%). This observation may indicate the simplicity of requesting (CTC), a convenient tests for both patients and clinicians and a satisfactory investigator of colorectal cancer.

Referral sources were not limited to surgery although constitute the majority of referral, other sources were recognised from medicine and patient's general practitioner (GP). Referral from surgery contributed to (73.5 %) 402 patients of total referral compared to (20%) 110 patients from medicine and (6.5%) 35 patients from GP (Figure 2).

In 511 (93.4%) had good colonic distention compared to 36 (6.6%) poor distention which did not limit visibility and results were satisfactory and did not require repeat procedure (Figure 3). Adding additional advantage of (CTC) as this procedure is well tolerated by patients, with no recorded complications, and in spite of poor preparation was thoroughly completed regardless of patients or operators factors.

The simplicity of (CTC) as a modality of an alternative to colonoscopy was clear in many studies explored further the benefits of (CTC) as a combined test in detecting colonic and extra colonic pathologies. Many European trials highlighted the ability of (CTC) in detecting organs and soft tissues pathologies such as aortic aneurysms, solid or complex cystic renal lesions, pancreatic masses, adnexal masses and lung lesions [14-19].

The impact of extra-colonic findings when screening is undertaken by CT colonography (CTC) was reviewed in Veerappue, *et al.* [15] study. In their study 2,277 patients had (CTC), extra-colonic findings were identified in 1,037 (46%) patients, 787 (34.5%) insignificant

and 240 (11.0%) significant findings. Seven high-risk lesions were identified (six extra-colonic malignancies and one large aortic aneurysm). (CTC) also identified six intracolonic malignancies and three adenomas with high-grade dysplasia. However, when considering extra-colonic findings, (CTC) increased the odds of identifying high-risk lesions by 78%. Further input into the extra-colonic advantage of imaging through (CTC) was revealed in Kim., *et al.* [16], (CTC) was assessed against extra-colonic findings in an asymptomatic screening population. In 2230 asymptomatic adults (mean age, 57.5 years with a conclusion enhanced (CTC) could safely detect asymptomatic early-stage extra-colonic malignant diseases without an unreasonable number of additional work-ups, thus reducing their morbidity or mortality.

Similarly, in our study (CTC) was able to provide additional benefits over colonoscopy and disclose 74 pathologies (13.5%) in 7 (1.2%) cancers were identified.

Nevertheless, (CTC) has a final challenge to prove its ability to compete with colonoscopy in detecting (CRC) and polyps and has a comparable sensitivity and specificity to colonoscopy [20-24].

In Pickhardt., *et al.* [20] ((Colonoscopy Vs Ct colonography in detecting colorectal cancer)) they looked through series of published studies of systematic review and meta-analysis of forty-nine studies providing data on 11,151 patients with a cumulative colorectal cancer prevalence of 3.6% (414 cancers). The results showed high sensitivity of CT colonography for colorectal cancer with 96.1% vs 94.7% for colonoscopy.

While the literature started to saturate with the role of (CTC) in detecting colorectal cancer, meanwhile, researchers continued to explore the role of non-invasive (CTC) in detecting the precursor of colorectal cancer such as polyps [25-32].

In its early stages, a systematic review and meta-analysis of forty-seven studies of 10,546 patients, Chaparro., *et al.* [28] in 2009 explored the Accuracy of computed tomographic colonography for the detection of polyps and colorectal tumours The results showed consistently high specificity of 83% in detecting colorectal polyps.

Nevertheless, 3 years earlier, a literature review of (CTC) outcomes between 1994 and 2005 of seven largest publications, conducted by Ringstad., *et al.* [31] including his own experience ((CT colonography is a new method for the detection of colorectal cancer and polyps)) revealed 55 - 94% sensitivity and 92 - 98% specificity for polyps > or = 10 mm.

Similarly in our review, (CTC) detected polyp in 54 (9.8%) with a smallest polyp was 6 mm, and colorectal cancer found in 21 patients (3%), achieving sensitivity 94.9% and Specificity 97.6%.

Furthermore, looking into interval (CRC), Somerset Registry was followed up for 3.6 years and proved none of our patients with normal (CTC) has developed bowel cancer during this period.

In this quick review of our own experience, we found a good evidence of the advantage of (CTC) in assessing patients presenting with suspected colorectal cancer. (CTC) was a straight forward procedure, tolerated by all patients regardless of their age, sex, and associated comorbidities. All procedures completed and did not require repeat under special circumstances or re-bookings. In all cases (CTC) was able to provide a decision on further management without the need for further investigations and proved to be an end point imaging in investigating large bowel symptoms.

Furthermore, (CTC) was able to detect intra and extra bowel pathology, providing further evidence of its valuable roles and widest coverage in assessing patients presented with red flag symptoms of weight loss and anaemia.

With the rapid advance in imaging technology, and introducing CTC into training curriculum, there is a strong opportunity for (CTC) to evolve further in detecting early colorectal cancer and small polyps including serrated sessile adenomas.

## **Conclusion**

(CTC) has continued to demonstrate its ability to compete with colonoscopy as a reliable minimally invasive imaging tool in detecting polyps and cancer with additional benefits of detecting extra-colonic conditions.

## **Conflicts of Interest**

The authors have no conflicts of interest to declare.

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