# Diagnostic Performance of Computed Tomography Scan in Colorectal Carcinoma

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#### Abstract:

**Objectives**: To assess the diagnostic performance of Computed Tomography Scan in colorectal carcinoma. Material and methods: This cross sectional type of observational study was conducted in Department of Radiology and Imaging, Dhaka Medical College Hospital, Dhaka from July, 2019 to June, 2021. Patients with suspected colorectal mass, referred to Radiology & Imaging department of DMCH for imaging investigation were included. Purposive sampling technique was adopted & sample size was 60. **Results**: In the study, maximum number of patients 26(43.3%) were in the age group 46-60 year, mean age of the patient was  $52 \pm 12.71$  years. Out of 60 cases, 37(62%) cases were male and 23(38%) were female. Male to female ratio was 1.6:1. Out of 60 cases, CT scan revealed, 48(80%) as colorectal carcinoma and 12(20%) other than colorectal malignancy. Histopathological finding shows that, 51(85%) were diagnosed as colorectal carcinoma and adenocarcinoma was predominant cases (76.7%). Finally, comparison between histopathology and CT scan in the diagnosis of colorectal carcinoma was done. Among 48 CT diagnosed cases of colorectal carcinoma 45 were confirmed by histopathological evaluation. They were true positive and another three cases were false positive. Out of 12 cases of CT diagnosed colorectal carcinoma, histopathology confirmed 06 cases as colorectal carcinoma and rest 06 as other than colorectal carcinoma. They were false negative and true negative respectively. Sensitivity, specificity, positive predictive value,

Address of correspondence: Dr. Sharmin Rahman, MBBS, MD, Medical Officer, Department of Radiology and Imaging, Dhaka Medical College Hospital (DMCH), Dhaka. Mobile: +8801912236034. Email: sharminrahman6248@gmail.com negative predictive value and accuracy of CT in diagnosis of colorectal carcinoma were 88.2%, 66.6%, 93.7%, 50% and 85% respectively. **Conclusion:** Present study concluded that CT has proved to be a reliable method for the detection and evaluation of colorectal malignancy and has better sensitivity, specificity and positive predictive value.

Key Words: Colorectal carcinoma, CT scan.

#### Introduction:

Colorectal cancer (CRC) is the third most commonly diagnosed malignancy and the second leading cause of cancer death in the world. CRC arises through three distinct carcinogenic pathways including adenoma-carcinoma sequence, serrated pathway and inflammatory pathway. Genetic factors such as germline MLH1 and APC mutations have an etiologic role for development of CRC.<sup>1</sup> Obesity, sedentary lifestyle, red meat consumption, alcohol, and tobacco are also considered as risk factors for colorectal carcinogenesis. In addition to above risk factor high blood sugar level and gastrointestinal inflammation may increase risk of colorectal carcinogenesis.<sup>2</sup>

Overall across the entire population CRC incidence and mortality trends have been declining but these trends are rising in adults ages <50 years or early age population. Since 1994, incidence of CRC has been increasing 2% per year in an individual's younger than 50 years. Characteristic features of early onset CRC are more advanced stage at diagnosis stage (III and IV), more frequent poorly differentiated tumors, higher prevalence of signet ring histology and left colon sided location of primary tumor.<sup>3</sup> Colorectal cancer (CRC) incidence and mortality are increasing among

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persons in the United States younger than 50 years old.<sup>4</sup> Recently, the ACS updated their guidelines with recommendation that colorectal screening for everyone should begin at age 45 rather than age  $50.^5$ 

In 2016 there is an estimated 134,490 new colorectal cancer cases (70,820 males and 63,670 females) along with 49,190 colorectal cancer deaths (26,020 males and 23,170 females). Colorectal cancer ranks third, only behind prostate cancer and lung cancer, for new cases in males (8% of all new cancer cases), and behind breast cancer and lung cancer for new cases in females (8% of all new cancer cases). Similarly, only lung cancer and prostate cancer are expected to claim more U.S. male lives than colorectal cancer are expected to take more U.S. female lives (8% of total cancer deaths for both genders).<sup>6</sup>

Most colorectal cancers are diagnosed after onset of symptoms. Common presenting symptoms are rectal bleeding, weight loss, abdominal pain, diarrhea, constipation and abdominal tenderness.<sup>7</sup> Carcinoma of the rectum and sigmoid is one of most common sites of gastrointestinal tract malignancy and account 20% of all gastrointestinal malignancies.<sup>8</sup>

The modalities used for evaluation of colorectal carcinoma are barium enema, transrectal USG, colonoscopy, CT and MRI. Barium enema as well as colonoscopy provide excellent apprehension of the mucosa but they cannot determine the depth of mural invasion by the tumor or the extent of metastatic disease.9 CT is the choice of investigation in assessment of abdomen and retro peritoneum in clinically advanced disease and it also can assess the characteristics of primary tumor. Accuracy of CT has been greatly increased in both preoperative staging and postoperative surveillance of colorectal cancers due to recent advances in technology of CT scan such as MDCT, CT colonography and multiplanar reconstructions. CT is more easily available and less time consuming than MRI. MRI has several limitations compared to CT that is more expensive, sensitiveness to motion and other artifact and has lower spatial resolution. Regarding preoperative staging of colorectal cancer, no imaging modality is 100% accurate.<sup>10</sup>

Computed Tomography has an important role in management of colorectal cancer that is pretreatment staging of disease as well as assessing for response to treatment.<sup>11</sup> Abdominal computed tomography is valuable in planning surgery for colon cancer because it can demonstrate local extension of tumor as well as lymphadenopathy and metastasis to distant organ, predominant organ is liver.<sup>12</sup>

The validity of CT colonography as a screening tool for CRC has been expected to rise over time. According to prior studies, CT is suboptimal for assessment of local T stage and moderate for N stage disease. Recent advances in CT technology resulting some improvement in staging accuracy. In CTC, multi-detector CT helps in high resolution image acquisition of the entire large intestine in a single breath hold. Integrated 3D and 2D analysis with specialized post-processing software allows for detection of polyp, location and characterization of lesions. Adequate bowel preparation and gaseous distension of the colon are essential for optimum assessment. Newer techniques such as faecal tagging lower the need for vigorous bowel preparation and decreases false positives from the presence of adherent faecal matter.<sup>11</sup>

The diagnostic accuracy of CT in TNM colorectal cancer staging were 92.3% for T staging, 42.3% for N staging and 96.1% for M staging. CT can provide a one-stop examination for the proximal colonic evaluation as well as for overall pretreatment cancer staging of the abdomen and pelvis when performed with intravenous contrast enhancement.<sup>13</sup>

CT accuracy improves with lesion size as with other screening techniques. All patients with one or more polyps more than 10 mm or 3 or more polyps more than 6 mm should be referred for colonoscopy.<sup>14</sup>

Preoperative CT is typically performed in case of suspected haematogenous or distal nodal (e.g. para-aortic) metastases, suspected invasion into adjacent organs or abscess formation, unexplained or atypical symptoms and abnormal histologic results. The ultimate goal of CT is to determine if there is direct invasion of adjacent organs, lymphadenopathy or evidence of distant metastases.<sup>12</sup> So computed tomography is a sensitive method for detection of early cancer and provides a cost effective method in diagnosis of colorectal carcinoma. For this reason, purpose of this study is to assess the diagnostic performance of Computed Tomography Scan in colorectal carcinoma.

#### Material and methods:

This cross sectional study with purposive sampling technique was conducted at the Department of Radiology and Imaging, Dhaka Medical College Hospital, Dhaka from July, 2019 to June, 2021 to assess the diagnostic performances of Computed Tomography Scan in colorectal carcinoma.

#### Study procedure

A total of 60 patients with suspected colorectal mass of both sexes above 30 years of age referred to the Department of Radiology and Imaging, DMCH from various departments of same institution for CT scan of abdomen were included in this study. The condition was explained to the patients and informed consent was obtained from either patient or the attendant of the patient. All patients underwent MDCT scan.

**MDCT** examination technique: MDCT examination was performed using a 128 slice multi detector CT scanner (4<sup>th</sup> generation) – HITACHI SCENARIA, whole body scanner with dual head automated injector. Both pre and post contrast scan was obtained with the patients in supine position using 2.5 mm collimation, 1.5 mm pitch, 120 Kv, 150 mAS, 10 mm slice thickness with 10 mm interval. The included area was from the level of diaphragm to the pubic bone. Raw data was reconstructed with both soft tissue and bone algorithms & MDCT images in axial, reformatted coronal and sagittal planes were obtained. At first non-contrast scan was taken. 45ml of non-ionic water soluble iodinated contrast medium Iopamiro dissolved in 3 glass of water (15 ml in 1 glass) taking over a period of 30-45 min as oral contrast prior to IV contrast. 50 ml of non-ionic water soluble iodinated contrast medium (lopamiro) 370 mg/ml strength is used intravenously. After giving intravenous contrast medium, CT slices were obtained immediately. Per rectal contrast was also given when required.

**Diagnostic criteria:** Following features were taken for CT diagnosis of colorectal carcinoma.

- i. Discrete soft-tissue mass that narrows the colonic lumen
- ii. Focal colonic wall thickening and luminal narrowing
- iii. Breach in the continuity of gut walls or erosion
- iv. Local extension of tumor
- v. Mild to moderate heterogeneous contrast enhancement

**Image analysis:** MDCT images were interpreted by two expert radiologists and expressed as one of the following possible states: homogenously hypodense (water/fluid attenuation 0 to 20 HU), soft tissue density (attenuation 25-45 HU), mixed density, hyperdense (attenuation more than the surrounding soft tissue > 50 HU), after contrast administration, pattern of enhancement was noted. The lesions diagnosed as benign, malignant or inflammatory lesions. The findings of the CT scan were reviewed and interpreted meticulously.

**Comparison with histopathology:** After MDCT evaluation the patients underwent colonoscopic biopsy of the same lesion in Department of Gastroenterology, DMCH. Biopsy specimens were sent to Department of pathology, DMCH for histopathological examination. After collecting the reports comparison between CT scan findings and histopathological findings was done.

#### Statistical analysis:

Data for all variables were obtained from participants by using a pre-designed and easily understandable questionnaire. After editing and coding, Data cleaning validation and analysis was performed using the SPSS/PC software version 22 (IBM) and graph and chart by MS excel. The result was presented in tables. A "P" value <0.05 considered as significant. Continuous variables were expressed as mean, standard deviation and categorical variables as frequencies and percentages. The differences between groups were analyzed by Chi-square test. To make out the relation between binary diagnostic test and the presence or absence of disease, a 2/2 contingency table was constructed. Diagnostic Performance of Computed Tomography Scan in Colorectal Carcinoma

#### **Results & Observation:**

Table I shows the maximum number of patients 26(43.3%) were in the age group 46-60 year, followed by 21(35%) of patients in the age group 31-45 years. Mean age of the patient was  $52 \pm 12.71$  years.

## Table I

Distribution of the study patients by age (N=60)

Age (years)	Number of patients	Percentage (%)
31-45	21	35
46-60	26	43.3
61-75	13	21.7
$Mean \pm SD$	$52 \pm 1$	2.71
Range (min-	max) 31-75	years



**Fig.-1:** *Pie chart showing gender distribution of study subjects (N=60)* 

Gender distribution in pie chart (Fig 1) shows that 37(62%) cases were male and 23(38%) were female with a male to female ratio of 1.6:1.

Table II	
Distribution of patients according to CT scan findings (N=6	<i>50)</i>

CT scan findings	Frequency (N)	Percentage (%)	
Location			
Sigmoid colon	18	30	
Rectum	13	21.7	
Transverse colon	08	13.3	
Distal sigmoid and proximal Rectum	16	26.7	
Ascending colon	05	8.3	
Morphological pattern			
Asymmetrical wall thickening	40	66.7	
Circumferential wall thickening	13	21.6	
Mass forming	07	11.6	
Outline			
Smooth	12	20	
Irregular	48	80	
Density of lesion			
Isodense	53	88.3	
Hypodense	00	00	
Hyperdense	00	00	
Mixed	07	11.7	
Pattern of enhancement			
Heterogeneously	04	6.7	
Homogenously	56	93.3	
Fat strandification / Stranding			
Present	37	61.6	
Absent	23	38.3	
Regional Lymphadenopathy			
Present	17	28.3	
Absent	43	71.7	
Infiltration into adjacent structure			
Yes	05	8.3	
No	55	91.7	
Hepatic metastasis			
Present	06	10	
Absent	54	90	

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Table II shows distribution of patients according to CT scan findings. Most of tumor located in sigmoid colon (30%) & distal sigmoid and proximal Rectum (26.7%). Most of the cases (80%) had irregular outline and 66.7% present as asymmetrical wall thickening.

Table III		
$Distribution \ of \ cases \ according \ to \ CT \ scan$		
diagnosis (N=60)		

Diagnosis	Number of	Porcontago
Diagnosis	Number of	1 ercentage
	patients (N)	(%)
Colorectal carcinoma	48	80
Other than colorectal	12	20
malignancy		
Polyp	07	11.7
Inflammatory coli	tis 05	8.3

Table III shows distribution of cases according to CT scan finding. Out of 60 cases, 48(80%) were diagnosed as colorectal carcinoma, 12(20%) were other than colorectal malignancy.

 Table IV

 Distribution of cases according to

 histopathological finding (N=60)

Diagnosis	Number of	Percentage
	patients (N)	(%)
Colorectal carcinoma	<b>a</b> 51	85
Adenocarcinoma	46	76.7
Micropapillary carcinor	na 04	6.7
Carcinoid tumour	01	1.7
Other than colorecta	1 09	15
malignancy		
Hyperplastic polyp	04	6.7
Inflammatory colitis	03	05
Adenomatous polyp	02	3.3

Table IV shows that out of 60 cases, 51(85%) were diagnosed as colorectal carcinoma and among them adenocarcinoma was predominant in numbers (76.7%).

Table V

Comparison of CT scan diagnosis with histopathological diagnosis of colorectal malignancy (N=60)

CT scan findings	Histopathological diagnosis		Total	p-value
	Colorectal cancer (CRC)	Other than CRC		
Colorectal cancer (CRC)	45	3	48	0.001
Other than CRC	6	6	12	0.001
Total	51	9	60	

p-value reached from Chi-square test

True positive(TP)=45, False positive(FP)=03, False negative(FN)=06, True negative(TN)=06

Table V shows the comparison between histopathology test and CT scan test in the diagnosis of colorectal carcinoma. Out of 60 cases, 48 were diagnosed as colorectal carcinoma by CT of which 45 were confirmed by histopathological evaluation. They were true positive and another three cases were false positive. Out of CT diagnosed 12 cases of other than colorectal carcinoma, 6 were confirmed as colorectal carcinoma and 6 other than colorectal carcinoma by histopathology. They were false negative and true negative respectively. The difference was statistically significant (p < 0.05).

Bar diagram showing the validity test results. Sensitivity, specificity, positive predictive value, negative predictive value and accuracy of CT in diagnosis of colorectal carcinoma were 88.2%, 66.6%, 93.7%, 50% and 85% respectively.



**Fig.-2:** Bar diagram showing Validity test parameters of CT examination in the diagnosis of colorectal carcinoma (N=60)

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**Fig.-3**: (a, b) Axial and reconstructed sagittal post contrast CT Scan of abdomen showing carcinoma involving sigmoid colon and recto sigmoid junction evident by circumferential wall thickening in sigmoid colon and recto sigmoid junction. (c): Axial contrast enhanced CT scan of abdomen showing hypo dense lesion in right lobe of the liver.



**Fig.-4 (a, b):** Axial and reconstructed coronal post contrast CT scan of abdomen showing growth in mid part of ascending colon evident by circumferential wall thickening of mid part of ascending colon.



**Fig.-5 (a, b):** Axial and reconstructed sagittal post contrast CT scan of abdomen showing carcinoma in rectum and anal canal evident by circumferential wall thickening of rectum and anal canal resulting luminal narrow



**Fig.-6 (a, b):** Axial and reconstructed sagittal post contrast CT scan of abdomen showing carcinoma in sigmoid colon and proximal part of rectum evident by asymmetrical wall thickening of sigmoid colon and proximal part of rectum.

#### **Discussion**:

This cross sectional study was conducted in the Department of Radiology and Imaging, Dhaka Medical College Hospital, Dhaka to assess the diagnostic performance of Computed Tomography Scan in colorectal carcinoma. A total of 60 patients with suspected colorectal mass referred to Department of Radiology and Imaging, DMCH were enrolled in this study during July, 2019 to June, 2021. They had undergone CT scan of abdomen with contrast. Finally, comparison between CT scan findings and histopathological findings was done to determine sensitivity, specificity, accuracy, positive predictive value and negative predictive value.

In this study, maximum number of patients 26(43.3%) were in the age group 46-60 year followed by 31-45 years, 21(35%) mean age of the patient was  $52 \pm 12.71$  years. Finding consistent with result of previous study, Bohorquez et al<sup>15</sup> reported that average age of patient at CRC diagnosis was 57.4 years with 26.5% of cases having early onset CRC diagnosed by age of 50 years and Sultana et al<sup>10</sup> reported that mean age was  $50.27 \pm 14.5$  years. In this study, most of the patients were found in earlier age group. This may be due to environmental factor that is obesity, low physical activity, high consumption of red meat and genetic factor.

In present study, out of 60 cases 37 (62%) cases were male and 23 (38%) were female. Male to Female ratio was 1.6: 1. Sultana et al<sup>10</sup> reported that 113 (64.2%) were male and 63 (35.8%) were female with ratio of 1.8:1. Colvin et al<sup>16</sup> reported that 47 were female and 49 were male. In this study, male was found more than female may be due to men are more likely to have a diet high in red meat and more likely to smoke.

Regarding the site of lesions, in this current study it was observed that 18 (30%) lesions were in sigmoid colon and 16 (26.7%) lesions were in distal sigmoid and proximal rectum including recto sigmoid junction. Bohorquez et al<sup>15</sup> noted that most tumor were located in the rectum (42.7%). Ashraf et al<sup>9</sup> reported that most tumor were located in sigmoid colon and rectum. In my study, most of the lesion were found in left side of colon than right side of colon and scientist have suggested that left sided colon cancer were more common in male.

In this study, most of the cases that is 40 cases (66.7%) were present with asymmetrical wall thickening, circumferential wall thickening was seen in 13 (21.6%) cases and most of the cases 48 (80%) cases had irregular outline and 12(20%) cases had smooth outline. Ashraf et al<sup>9</sup> noted that 48 (44%) lesion was in the form of circumferential

thickening of the bowel wall and 27 (56%) were discrete focal mass. Horton et al<sup>12</sup> reported that CT typically demonstrates a discrete soft tissue mass that narrow the colonic lumen. Large masses may undergo central necrosis. Thus appear soft tissue with central low attenuation. Significant percentage of colorectal carcinoma manifest as focal colonic wall thickening and luminal narrowing. In particular rectum and sigmoid cancer may appears as asymmetrical nodular wall thickening that narrows the lumen.

In this study, out of 60 cases, perilesional fat strandification was present in 37 (61.6%) cases, regional lymphadenopathy was seen in 17(28.3%) cases, infiltration into adjacent organ was seen in 5(8.3%) cases and hepatic metastasis was present in 6(10%) cases. Singla et al<sup>8</sup> noted that out of 31 cases, pelvic lymphadenopathy was seen in 14(45.2%) cases, pericolic fat strandification was seen in 24 (77%) cases, infiltration of adjacent organ was seen in 5(16%) cases and metastasis was seen in 5(16%) cases.

In this current study, regarding CT diagnosis, it was observed that out of 60 cases, 48 (80%) were diagnosed as colorectal carcinoma, 12(20%) were other than colorectal carcinoma. Histopathological findings were evaluated in all cases. Out of 60 case, 51 (85%) were diagnosed as colorectal carcinoma and adenocarcinoma was predominant 46(76.7%). Bohorquez et al<sup>15</sup> reported that most tumors were adenocarcinoma (91.5%).

Finally, comparison between CT and histopathological finding was conducted. Out of 60 cases, 45 cases were true positive, 3 cases were false positive and 6 cases were false negative, 6 cases were true negative. Sensitivity, specificity, positive predictive value, negative predictive value and accuracy of CT in diagnosis of colorectal carcinoma ware 88.2%, 66.6%, 93.7%, 50% and 85% respectively. Colvin et al<sup>16</sup> noted that sensitivity of CT in detecting colorectal cancer was 100% (95% confidence interval [CI]: 19.8-100%) and specificity was 95.7% (95% CI: 88.8% - 98.6%) the positive predicative value was 33.3% [95% CI: 6.0-75.9% and negative predictive value was 100% (95% CI: 94.8-100%). Ashraf et al<sup>9</sup> noted that sensitivity of CT in detection of colorectal carcinoma was 92%. In this study, validity test parameters were slightly lower than previous studies may be due some technical factors that is faulty biopsy sample collection from the site of lesion and slightly higher slice thickness (10mm) in abdominal CT in Dhaka Medical College Hospital. Another factor was that patient did not come with adequate bowel preparation while performing abdominal CT scan. Regarding Chi square test, comparison of CT diagnosis of colorectal carcinoma with histopathological diagnosis showed, the P value is significant (<0.05). Therefore, this study establishes that CT scan is an accurate radiological modality to evaluate colorectal carcinoma.

### **Conclusion:**

Present study results demonstrated that CT scan has a definite role in evaluation of colorectal cancer.

#### **References:**

- Keum N, Giovannucci E. Global burden of colorectal cancer: emerging trends, risk factors and prevention strategies. *Nature reviews Gastroenterology & hepatology* 2019 Dec;16(12):713-32.
- Rawla P, Sunkara T, Barsouk A. Epidemiology of colorectal cancer: incidence, mortality, survival, and risk factors. Gastroenterology Review/Przegl<sup>1</sup>d Gastroenterologiczny 2019 Jan 6;14(2):89-103.
- Mauri G, Sartore Bianchi A, Russo AG, Marsoni S, Bardelli A, Siena S. Early onset colorectal cancer in young individuals. *Molecular oncology* 2019 Feb;13(2):109-31.
- Low EE, Demb J, Liu L, Earles A, Bustamante R, Williams CD, Provenzale D, Kaltenbach T, Gawron AJ, Martinez ME, Gupta S. Risk factors for early-onset colorectal cancer. *Gastroenterology* 2020 Aug 1;159(2):492-501.
- 5. Peterse EF, Meester RG, Siegel RL, Chen JC, Dwyer A, Ahnen DJ, Smith RA, Zauber AG, Lansdorp Vogelaar I. The impact of the rising colorectal cancer incidence in young adults on the optimal age to start screening: microsimulation analysis I to inform the American Cancer Society colorectal cancer screening guideline. *Cancer* 2018 Jul 15;124(14):2964-73.

- 6. American Cancer Society (ACS), 2016. Cancer Facts & Figures 2016. Available at: < file:///C:/Users/absbd/AppData/Local/Temp/ cancer-facts-and-figures-2016.pdf> [Accessed 15 March 2021].
- Hamilton W, Round A, Sharp D, Peters TJ. Clinical features of colorectal cancer before diagnosis: a population-based case-control study. *British journal of cancer* 2005 Aug;93(4):399-405.
- 8. Singla SC, Kaushal D, Sagoo HS, Calton N. Comparative analysis of colorectal carcinoma staging using operative, histopathology and computed tomography findings. *International journal of applied & basic medical research* 2017;7(1):10-4.
- Ashraf K, Ashraf O, Haider Z, Rafique Z. Colorectal carcinoma, preoperative evaluation by spiral computed tomography. JPMA. The Journal of the Pakistan Medical Association 2006 Apr;56(4):149-53.
- Sultana N, Khan S, Baloch SU. Diagnostic accuracy of contrast enhanced computed tomography in staging of colorectal carcinoma. *Pakistan Armed Forces Medical Journal* 2018 Oct 31;68(5):1076-81.
- Tan CH, Iyer R. Use of computed tomography in the management of colorectal cancer. *World Journal of Radiology* 2010 May 1;2(5):151-8.

- 12. Horton KM, Abrams RA, Fishman EK. Spiral CT of colon cancer: imaging features and role in management. *Radiographics* 2000 Mar;20(2):419-30.
- Narayanan S, Kalra N, Bhatia A, Wig J, Rana S, Bhasin D, Vaiphei K, Khandelwal N. Staging of colorectal cancer using contrastenhanced multidetector computed tomographic colonography. *Singapore Med J* 2014 Dec;55(12):660-6.
- Kim DH, Pickhardt PJ, Hoff G, Kay CL. Computed tomographic colonography for colorectal screening. *Endoscopy* 2007 Jun;39(06):545-9.
- Bohorquez M, Sahasrabudhe R, Criollo A, Sanabria-Salas MC, Velez A, Castro JM, Marquez JR, Mateus G, Bolanos F, Panqueva C, Restrepo JI. Clinical manifestations of colorectal cancer patients from a large multicenter study in Colombia. *Medicine* 2016 Oct 1;95(40): e4883.
- 16. Colvin H, Lukram A, Sohail I, Chung KT, Jehangir E, Berry J, Babu H, Hinson F. The performance of routine computed tomography for the detection of colorectal cancer. The Annals of the Royal College of Surgeons of England 2013 Oct;95(7):473-6.