ORIGINAL ARTICLE

Role of Multi-detector CT Scan in Evaluation of Colorectal Cancer

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Summary

Colorectal cancer is the third most common cancer worldwide which represent one of the leading causes of death . Multidetector computerized tomography scan (MDCT) is a noninvasive method of cancer detection . This study aimed to evaluate the role MDCT scan in diagnosis or detection of colorectal cancer .Hence, a cross sectional study conducted in the CT unite during a period of 18 months, included 56 Iraqi patients with suspected signs or symptoms of colorectal cancer were referred from GIT center or other department for CT scan study. Thirty three males and twenty three females. Out of total 56 patients, twenty five patients (16 male & 9 female) are diagnosed as having cancer by MDCT , while colonoscopy/ laparotomy findings showed 38 patients (24 male &14 female). Out of the 56 patients, 13 (8 male & 5 female) appeared normal with MDCT,11 patients (6 male & 5 female) was normal in both studies and 7 patients (3 males & 4 females) considered malignant in MDCT. By histopathology (4 cases of tuberculosis,2cases of Crohn's disease & one with diverticulitis) . This study shows MDCT scan sensitivity (65.7%), specificity (61.1 %) & accuracy(64.2 %) with PPV (78.1 %),NPV (45.8 %)

Keywords: *Colorectal cancer , CT scan, Multi-detector , Epidemiology, Characteristics*

1 | INTRODUCTION

Colorectal cancer (CRC) is the third most common cancer in the world and the second leading cause of cancer-related deaths in the United States accounting for approximately 10% of all cancer deaths in both men and women combined (1, 2). Globally, the incidence of CRC varies widely with higher incidence rates in North America, Australia, northern and western Europe. Developing countries have lower rates, particularly Africa and Asia, mostly because of reduced consumption of saturated fat and proteins and increased consumption of dietary fibres(3, 4) .   Colorectal cancer is a curable disease, if detected in early stage. Regular colon cancer screening has been recommended by the medical community for all individuals over 50 years of age and 10 years earlier than the youngest affected member if significant family history of colorectal cancer had occurred (5). Since the beginning of the 1970's, when computed tomography (CT) and later magnetic resonance imaging (MRI) were introduced as cross-sectional imaging modalities, there have been several developments that have widened their use. While being used primarily for detection of distant metastases, recurrent disease and staging, currently, CT scan and MRI have been used for detection of the colorectal cancer (6,7). CT was first among the two to become widely used for abdominal and pelvic imaging. CT colonography (CTC),   visualization of colon, as an imaging technique uses data generated from CT imaging of the fully prepared and gas-distended colon to generate two-dimensional (2D) and three-dimensional (3D) images of the colon. It was first reported by Vining and Gelfand in 1994 (8) as a rapid, noninvasive imaging method to investigate the colon and rectum (9,10) . With the advent of multi- detector CT and CT software, volumetric data of the entire colon are acquired in a few seconds of CT scanning with a total of 10–20 min of examination time. Assessment of the colon requires assessment of the   2D (axial and coronal planes) and 3D images which also includes endoluminal navigation of the colon. Since the advent of CTC, it has been regarded as a potential alternative technique to conventional colonoscopy for the detection of colorectal polyps and cancer (8). The lifetime risk of developing fatal cancer as a result of ionizing radiation exposure is estimated by the International Commission on Radiological Protection, to be approximately 5% per Sievert (11). The effective dose of CTC

is estimated at about 8.8 mSv (range 4–12 mSv) and carries a risk of 0.02% in a 50 year-old individual and is lower for older patients (41). In order to minimize the dose, efforts have been made to adapt the tube current to the minimum accepted dose while not reducing performance. No change was reported in the diagnostic efficacy when lowering the tube current from 140 to 70 mA using single-detector CT (12) and multidetector CT (13). Low-dose virtual colonoscopy was shown to have excellent sensitivity and specificity for detection of colorectal neoplasms 10 mm and larger (14). The performance of virtual colonoscopy using an ultra-low radiation dose of 10 mAs has been shown to compare favourably with conventional colonoscopy in the detection of polyps larger than 6 mm with markedly decreased performance for small polyps of 5 mm or smaller (15). The reduction in tube current has been shown to result in more noise with degradation of image quality. However, it has recently been shown (16) that combined x, y and z-axis tube current modulation leads to significant reduction of radiation exposure without loss of image quality. This study aimed to assess the accuracy of Multidetector computed tomography (MDCT) scan in the diagnosis and local staging of colorectal cancer.

2 | PATIENTS AND METHODS

This was a cross-sectional study carried out during a period of 2 years 2017 and 2018. A total of 63 patients with alarming signs and symptoms   of colorectal cancer and examined with colonoscopy , were examined with MDCT. After well preparation of the patients,   MDCT used to get pictures in axial , coronal & sagittal planes to get three dimensional images. Those with abnormal CT or colonoscopy findings underwent surgical exploration, where the lesion evaluated by histopathological examination to compare the final result with CT scan findings . Seven patients were excluded from the study due to difficulty in follow up, in addition to that any patient with recurrent CRC and those with colorectal mass and associated liver metastasis were also excluded. The alarming features of CRC include bleeding per rectum, changes in bowel habits such as diarrhoea, constipation, or stools that is narrower than usual, persistent cramps and or steady abdominal pain associated with bloating or fullness. Other features are pallor , weakness / fatigue, anorexia ,   recurrent   vomiting, and weight loss . Data collected using a pre-

constructed data collection sheet to report demographic data from all the patients, as well as features of colorectal cancer, colonoscopy and MDCT scan findings. Study protocol: All patients has been examined by TOSHIBA Scanner, 64 Slice made in Japan(Aquillon 64, V4.51 ER 010, Toshiba Medical Systems, Tochigi, Japan). Bowel preparation just as barium enema , including 3 days pre exam : 2 days of low residue diet , 3rd day of fluid only and repeated enema for cleansing of the bowel and no thing by mouth in the exam day. Sometimes introduction of room air into the rectum via manual enema or introduction of Foleys to the rectum with the patient in prone position , & using sphegmo monometer for inflating the large bowel , additionally, a smooth muscle relaxant was prescribed. Oral contrast is usually used after dilution with water (30-40 ml of 350 mg/ml non-ionic water soluble iohexol mixed with 1000 ml water) at least 2 hours before the examination. Intravenous contrast was also used , 50-100 ml iohexol 350 mg /ml as rapid injection by the injector with 3-5 ml /sec flow rate .

 Test performance characteristics (validity parameters):

Sensitivity: is the conditional probability that a diseased person will have a positive result. It is calculated according to the following equation:

Sensitivity = True positive / True positive + False negative x 100%

Specificity: is the probability that a diseased free person to has a negative result. It was calculated according to the following equation

Specificity = True negative / True negative + False positive x 100%

Accuracy: represent the proportion of the subjects in which the test agreed with their status (true positive and true negative) out of all tested subjects.

Accuracy = True positive +True negative / Total number x 100%

The positive and negative predictive values (PPV and NPV respectively) are the proportions of positive and negative results in statistics and diagnostic tests that are true positive and true negative results

PPV% = True positive / True positive +False positive x 100%

NPV% = True negative / True negative +False negative x 100%.

Statistical analysis was performed using the Statistical Package for Social Sciences (SPSS) version 20, appropriate statistical tests were applied accordingly with a level of significance (P. value ≤ 0.05).

3 │ RESULTS

A total of 56 patients were enrolled in this study, the age and gender distribution of the studied group is shown in (**Table 1**). Among the studied group, 25 patients (16 males & 9 females) were diagnosed as having cancer by MDCT and 31 were not. Colonoscopy/ laparotomy findings revealed colorectal cancer in 38 patients (24 male &14 female). However 13 patients (8 male & 5 female) appeared normal with MDCT as (false negative) result ,11 patients (6 male & 5 female) were normal in both studies (true negative) , 7 patients (3 male & 4 female) considered malignant in MDCT as (false positive) results due to benign nature by histopathological evaluation (3 cases of tuberculosis,2 cases of crhons disease ,one case of stromal tumor & other with diverticulitis) . This study shows MDCT scan sensitivity (65.7%), specificity (61.1%) & accuracy (64.2 %) with PPV (78.1 %),NPV (45.8 %), (**Table 2**).

Comparison between MDCT scan and the post. operative local T staging of colorectal cancer. The CT scan could not detect all 6 patients with T1 stage and detect only 2 patients from 9 in T2 stage .All patients with T3 and T4 stages are detected with MDCT scan (14 patients T3 & 9 patients T4 post. operatively) ,but 2 patients with stage T4 are under estimated as T3 by CT scan . The sensitivity of MDCT for early colorectal cancer stages (T1 , T2) was 13.3 % and for advanced stages (T3,T4) was 100%, (**Table 3**). Alarming signs and symptoms of colorectal cancer reported in 56 patients are summarized in (**Figure 1**), the main symptoms & signs in 38 patients with proved colorectal cancer that the commonest complaint of patients was abdominal pain 29 patient (76.6 %) followed by anemia 21patients (56.3 %) , bleeding per rectum15 patients (40 %), constipation 11 (30 %), diarrhea10 patients (26.6 %) and weight loss in 6 patients (16.6 %) (**Figure 1)**. The CT scan findings of histopathologically proved colorectal cancer patients with different stages excluding those with distant metastasis. The commonest finding was large bowel mass 15 patients (39.4 %),while 13 patients (34.2 %)

appeared   normal .Other findings included   7 patients   (18.4 %) with thick bowel wall or narrowing and 3 patients (7.9 %) presented with complicated tumor (2 patients with large bowel obstruction and 1 with fistula formation (**Figure 2**) .

Distribution of histopathological proved cancer along the large bowel including caecum, ascending colon, transverse colon, descending colon & rectosigmoid region. The commonest site was rectosigmoid region 17 patients (44.7 %), the second most common site was the caecum 12 patients, (31.5 %). Other sites included 4 patients (10.5 %) within descending colon, 3 patients (7.9 %) within ascending colon and 2 patients (5.2 %) within transvers colon, (**Figure 3**).

Table 1. Age and gender distribution

Age (year)	Male		Female		Total	
	No.	%	No.	%	No.	%
10 – 19	1	3.0	0	0.0	1	1.8
20 - 29	2	6.1	1	4.3	3	5.4
30 – 39	3	9.1	3	13.0	6	10.7
40 – 49	8	24.2	5	21.7	13	23.2
50-59	8	24.2	8	34.8	16	28.6
60 – 69	10	30.3	5	21.7	15	26.8
≥ 70	1	3.0	1	4.3	2	3.6
Total	33	100.0	23	100.0	56	100.0

Table 2. Correlation of CT-scan finding and colonoscopic/ histopathological results in all patient with suspected colorectal cancer

Ct-scan finding	Histopathological results		Total
	Malignant	Benign	
Malignant	25	7	32
Benign	13	11	24
Total	38	18	56

Validity parameters

Sensitivity	65.7%
Specificity	61.1%
Accuracy	64.2%
PPV	78.1%
NPV	45.8%

Table 3. Comparison between CT scan & postoperative local (T) staging in patients with colorectal cancer .

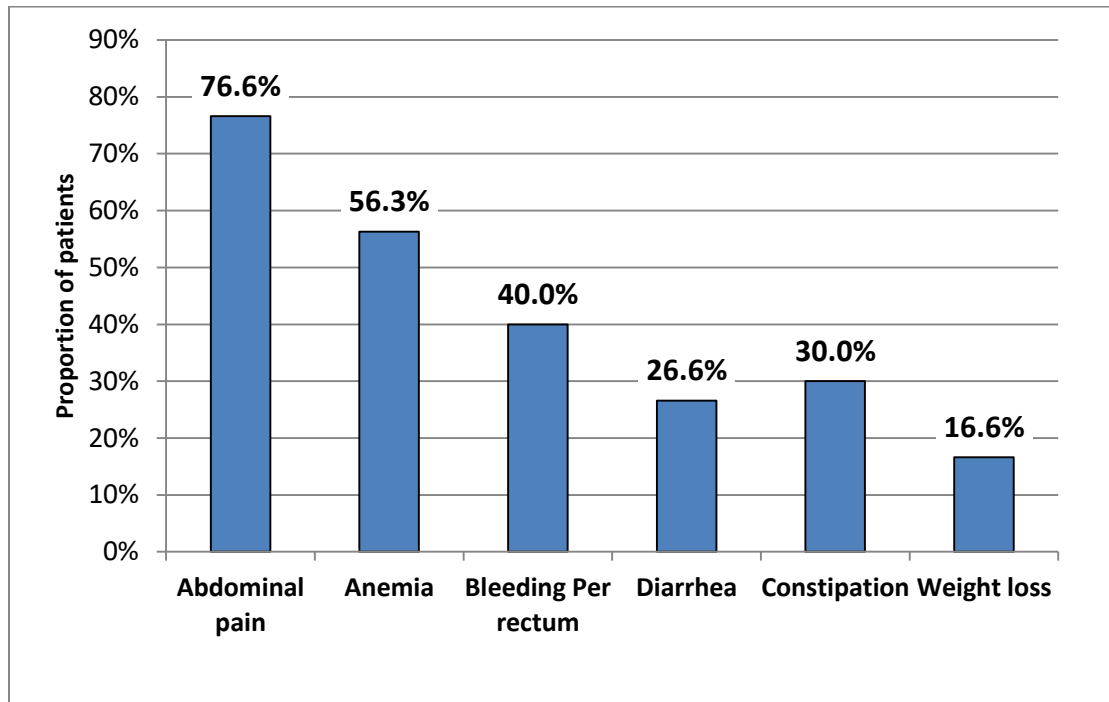| T stage	CT scan staging	Post. operative staging
T1	0	6
T2	2	9
T3	16	14
T4	7	9
Total	25	38

Figure 1. Distribution of patient by signs and symptoms of colorectal lesions
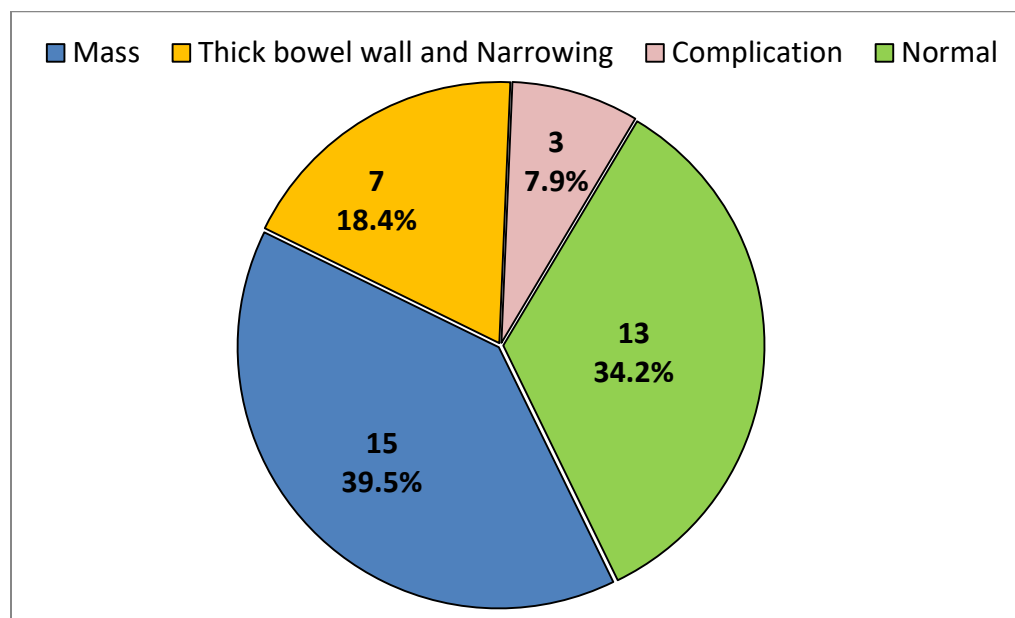

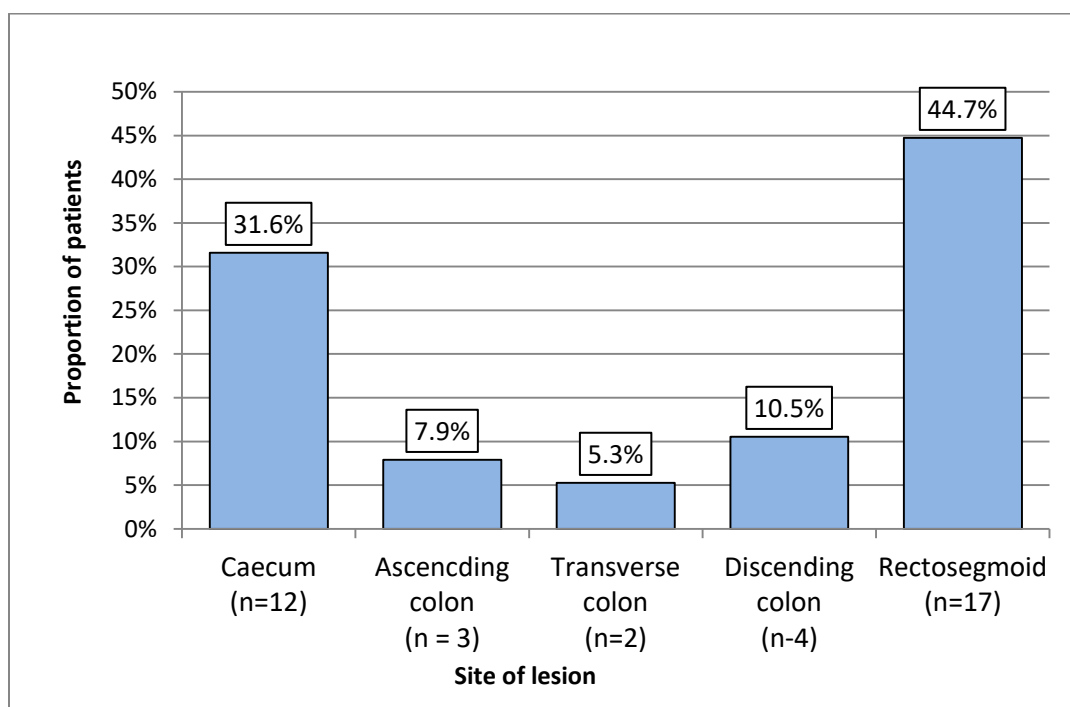*Figure 2. CT- Scan finding in 38 patients with colorectal cancer*

Figure 3. Distribution of colorectal cancer according to the site of lesion

4 │ DISCUSSION

Our study showed that 65.7 % sensitivity , 61.1 specificity , 64.2 % diagnostic accuracy with 78.1 % positive predictive value & 45.8 % negative predictive value of MDCT scan in diagnosis of colorectal cancer . These findings were similar to the findings of Robert et al (2010) in the study of 104 patients that found 60.4 % sensitivity , 50 % accuracy with 74.2 % positive predictive value(28). Borda et al (2012), in the study of 223 patients of colorectal cancer found 79.1 % sensitivity 76.3 % accuracy (29) which is higher than our results . Our study shows very low 13.3 % and very high 100 % sensitivity of CT scan for detection of early (T1,T2) and late (T3,T4) stages of colorectal cancer respectively. These findings were similar to the findings of Smith et al (2007) in the study of 126 patients with proved colorectal cancer that found 92.4 % sensitivity for detection of (T3,T4) tumor invasion and very poor sensitivity for (T1,T2) stages (30) . Signs and symptoms of patients with colorectal cancers represented (76.6%) abdominal pain, bleeding per rectum (40%), weight loss (16.6%), diarrhoea (26.6%), constipation (30%) and (56.3%) anemia. However, these finding

disagreement with the findings of Ries et al., (2007) and Johns et al., (2001) who reported that bleeding per rectum, diarrhea, constipation, abdominal pain and anemia are the most common signs and symptoms of colorectal cancer (20,31). The main features of colorectal cancer are, bowel mass which is the most common findings (39.47 %) and apart from normal bowel picture in early tumour invasion (34.21 %) , the wall thickening or narrowing (18.42 %) & complications as bowel obstruction or   fistula (7.89 %) are other recognized pictures . However, these finding were in agreement with the findings of Karen et al (1999) that at CT, colorectal cancer typically appears as a discrete soft-tissue mass that narrows the colonic lumen (32). Colorectal cancer can also manifest as focal colonic wall thickening and luminal narrowing. Complications of primary colonic malignancies such as obstruction, perforation   and fistula can be readily visualized. The distribution of colorectal cancer in number & frequency in large bowel which divided in to 5 sites (caecum ,ascending colon ,transverse colon ,descending colon & rectosegmoid region) .The most common site of colon cancer is the rectosegmoid region 17 patients (44.74 %) followed by the caecum 12 patients (31.58 %) .This result were in agreement with Steve et al (2003) which found that most tumours being left sided in the rectosigmoid region (55 %) followed by the caecum (13 %), (26).

5 │ CONCLUSIONS

MDCT scan is a good non-invasive modality for detection of colorectal cancer with fair accuracy .However it is inaccurate in the detection of early tumour invasion (T1 & T2) . We suggested the MDCT scan can be used in adjunct with other modalities for CRC detection in those with alarm features .However, further studies with larger sample size are highly suggested   for further assessment and evaluation of the accuracy of MDCT scan in those with early stages of CRC

Ethical Issue:
   All ethical issues were approved by the author, in accordance with Ethical Principles of

Declaration of Helsinki of the world Medical Association, 2013, for research involving human subjects

6 | BIBLIOGRAPHY

1. Ransohoff DF, Sandler RS: Clinical practice: screening for colorectal cancer. N Engl J Med 2002; 346: 40–44.

2. Jemal A, Tiwari RC, Murray T, et al: Cancer statistics. CA Cancer J Clin 2004; 54: 8–29.

3. Howe HL, Wu X, Ries LA, Cokkinides V, Ahmed F, Jemal A, et al . Annual report to the nation on the status of cancer, 1975-2003, featuring cancer among U.S. Hispanic/Latino populations. Cancer 2006;107: 1711-4. 2.

4. Parkin DM, Pisani P, Ferlay J. Global cancer statistics. CA Cancer J Clin 1999; 49: 33-64, 1.

5. Parker SL, Tong T, Bolden S, Wingo PA: Cancer statistics. CA Cancer J Clin 1996; 46: 5– 27.

6. Meyer JE, Dosoretz DE, Gunderson LL, Stark P, Kopans DB: CT evaluation of locally advanced carcinoma of the distal colon and rectum. J Comput Assist Tomogr 1983; 7: 265–267.

7. Ruf G, Hauenstein KH, Rudolf M, Schoffel U, Lausen M, Wimmer B: (Preoperative staging of rectal cancer with computer tomography). (German). Langenbecks Arch Chir 1986; 368: 3–11.

8. Fenlon HM. Colorectal neoplasm detection using virtual colonoscopy: a feasibility study. Gastrointestinal endoscopy. 2000 Mar;51(3):369-71.

9. Vining DJ. Technical feasibility of colon imaging with helical CT and virtual reality. InProc. Ann. Meeting of Amer. Roentgen Ray Soc. 1994 (Vol. 104).

10. Thoeni RF. Colorectal cancer radiologic staging. Radiol Clin North Am 1997; 35:457–83.

11. Fletcher JG, Johnson CD, Krueger WR, Ahlquist DA, Nelson H, Ilstrup D, Harmsen WS, Corcoran KE. Contrast-enhanced CT colonography in recurrent colorectal carcinoma: feasibility of simultaneous evaluation for metastatic disease, local recurrence, and metachronous neoplasia in colorectal carcinoma. American Journal of Roentgenology. 2002 Feb;178(2):283-90.

12. Hara AK, Johnson CD, Reed JE, Ahlquist DA, Nelson H, Ehman RL, Harmsen WS. Reducing data size and radiation dose for CT colonography. AJR. American journal of roentgenology. 1997 May;168(5):1181-4.

13. Van Gelder RE, Venema HW, Serlie IWO. CT Colonography at different radiation dose levels: feasibility of dose reduction. Radiology 2002; 224: 25–33.

14. Macari M, Bini EJ, Xue X, Milano A, Katz SS, Resnick D, Chandarana H, Krinsky G, Klingenbeck K, Marshall CH, Megibow AJ. Colorectal neoplasms: prospective comparison of thin-section low-dose

multi–detector row CT colonography and conventional colonoscopy for detection. Radiology. 2002 Aug;224(2):383-92.

15. Iannaccone R, Catalano C, Mangiapane F, Murakami T, Lamazza A, Fiori E, Schillaci A, Marin D, Nofroni I, Hori M, Passariello R. Colorectal polyps: detection with low-dose multi–detector row helical CT colonography versus two sequential colonoscopies. Radiology. 2005 Dec;237(3):927-37.

16. Graser A, Wintersperger BJ, Suess C, Reiser MF, Becker CR. Dose reduction and image quality in MDCT colonography using tube current modulation. American Journal of Roentgenology. 2006 Sep;187(3):695-701.

17. Kronborg O, Fenger C. Clinical evidence for the adenoma-carcinoma sequence. European journal of cancer prevention: the official journal of the European Cancer Prevention Organisation (ECP). 1999 Dec 1;8:S73-86.

18. Ries L, Melbert D, Krapcho M, et al. (eds). SEER Cancer Statistics Review, 1975-2007. Bethesda, MD: National Cancer Institute; 2007.

19. Johns LE, Houlston RS. A systematic review and meta-analysis of familial colorectal cancer risk. The American journal of gastroenterology. 2001 Oct 1;96(10):2992-3003..

20. Alberta Cancer Board. Colorectal Cancer Control in Alberta. 2007.

21. Rex DK, Rahmani EY, Haseman JH, Lemmel GT, Kaster S, Buckley JS. Relative sensitivity of colonoscopy and barium enema for detection of colorectal cancer in clinical practice. Gastroenterology. 1997 Jan 1;112(1):17-23.

22. Copel L, Sosna J, Kruskal JB, Raptopoulos V, Farrell RJ, Morrin MM: CT colonography in 546 patients with incomplete colonoscopy. Radiology 2007; 244: 471–478.

23. Vining DJ. Technical feasibility of colon imaging with helical CT and virtual reality. InProc. Ann. Meeting of Amer. Roentgen Ray Soc. 1994 (Vol. 104).

24. Vining DJ. Technical feasibility of colon imaging with helical CT and virtual reality. InProc. Ann. Meeting of Amer. Roentgen Ray Soc. 1994 (Vol. 104).

25. Fletcher JG, Johnson CD, Krueger WR, Ahlquist DA, Nelson H, Ilstrup D, Harmsen WS, Corcoran KE. Contrast-enhanced CT colonography in recurrent colorectal carcinoma: feasibility of simultaneous evaluation for metastatic disease, local recurrence, and metachronous neoplasia in colorectal carcinoma. American Journal of Roentgenology. 2002 Feb;178(2):283-90.

26. Steve Halligan , Philip J.A.Robinson chapter 21: large bowel diseases in David Sutton ,text book of radiology and imaging , seventh edition , 2003, page 641 ,table 21.2

27. Greene FL PD, Fleming ID ,Fritz A, et al : AJCC cancer staging manual ,6th ed.new York : Springer , 2002.

28. Lee J, Voytovich A, Pennoyer W, Thurston KT, Kozol RA. Accuracy of colon tumor localization: Computed tomography scanning as a complement to colonoscopy. World J Gastrointest Surg, 2010, 2(1): 22-5.

29. Fernando Borda, Francisco Javier Jiménez, Ana Borda, Jesús Urman, Silvia Goñi, Miriam Ostiz and José Manuel Zozaya Endoscopic localization of colorectal cancer: Study of its accuracy and possible error factors 512-517, 2012.

30. NJ Smith1, N Bees2, Y Barbachano3, AR Norman3, RI Swift1 and G Brown Preoperativecomputed tomography staging of nonmetastatic colon cancer predicts outcome: implications for clinical trials 1030 – 1036, 2007

31. Lynch KL, Ahnen DJ, Byers Y, et al. First-degree relatives of patients with advanced colorectal adenomas have an increased prevalence of colorectal cancer. Clin Gastroenterol Hepatol. 2003; I: 96-102.

32. Horton KM, Abrams RA, Fishman EK. Spiral CT of colon cancer: imaging features and role in management. Radiographics. 2000 Mar;20(2):419-30.