IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 20, Issue 1 Ser.14 (January. 2021), PP 11-20
www.iosrjournals.org

Role of MSCT, MRI, DWI, PET / CT, 3D-Reconstruction and Virtual Endoscopy in Detecting Colon Diseases and Colorectal Cancer

V. Sokolov[1], V. Tsvigovsky[1], T. Dorofeeva[1], G. Rozhkovskaya[1], O. Korsun[1], L. Anischenko[1], E. Doikova[1], O. Mirza[1], O. Dius[1]
[1]*Department of Radiation Diagnostics, Therapy and Oncology, Odessa National Medical University, Ukraine*

Abstract:
Background*: Currently in the world there is a tendency of continuous growth in the incidence of cancer of the rectum and colon. The tendency to a continuous increase in the incidence is especially pronounced in industrialized countries. Within this re-search we have set to establish MSCT criteria for the infiltration and exophytic growth of colon cancer, to establish the capabilities of DWI and PET / CT in the diagnosis of to establish criteria for the invasion of tumor intestinal walls, to de-termine the effectiveness of chemoradiation and surgical treatment, as well as to determine the radiological criteria for recurrent tumors.*
Materials and Methods*: MSCT colonoscopy was performed in 345 patients (240 with suspected cancer, 105 with polyps). Patients underwent standard preparation. The usual radiation dose for MSCT colonoscopy is 6-12 mGy. During screening, it is possible to re-duce the dose to 3-6 mGy ("low dose technique"). The low dose technique should be used to determine the colonoscope obstruction cause or in case performing irrigoscopy is not possible. The contrast medium is often required to envelope the pebble poop. We used standard abdominal radiography, MSCT (multispiral computed tomography), MRI (magnetic resonance imaging), DWI (diffusion-weighted images).*
MSCT studies were carried out on 4 and 64-slice Toshiba devices. MRI examinations were performed with a field strength of 1.5T PET/CT were performed using labeled 18F-FDG (2-fluorodesoxyglucose).
Results*: MSCT, including MSCT endoscopy, is a highly informative method for detecting invasive colon cancer, showing sensitivity and specificity indicators approaching to 100%, that may not be extended to colon polyps' diagnosis (76%). Use of MSCT can increase the accuracy of preoperative detection of a colon tumor, clarify the stage of the disease, detect tumor recurrence, and determine the effective-ness of radiation therapy. The sensitivity of MSCT for detecting polyps of 5-6 mm in size was 59%, with optical colonoscopy - 76%, the sensitivity of MSCT for detecting polyps >10 mm was 91%, with optical colonoscopy - 95%.*
The advantage of virtual colonoscopy is that it does not require complex preparation of the patient for the study and does not injure them, since this method is, in fact, variant of computed tomography. This technique is well suited for screening patients from risk groups, especially in the presence of polyps, because they often undergo malignant transformation.
Conclusion: *MSCT, DWI, MRI are useful in the diagnosis and definition of the metastatic focus of neoplasm.*
18F-FDG PET / CT can provide prognosis information after surgical resection of colon cancer. PET / CT provides a significant advantage in improving diagnosis and therapeutic monitoring of patients, monitoring treatment responses.
Key Word*: colon cancer MSCT criteria, DWI, PET / CT, diagnosis of colon and rectal cancer, recurrent tumors*

Date of Submission: 07-01-2021 Date of Acceptance: 23-01-2021

I. Introduction

Cancer of the rectum and colon (colorectal cancer, or CRC) today, without exaggeration, can be described as a global problem[1]. It gradually occupies 2nd place by morbidity. The trend towards a continuous increase of the incidence is especially pronounced in industrialized countries, those with imposed "industrial" lifestyle among many factors. It is their nutrition that most scientists associate with the rapid increase in morbidity and mortality rates from colorectal cancer. According to the WHO, about one million of new colorectal cancer cases are registered annually in the world[5]. In the US, mortality from CRC is in third place. In Ukraine, in 2018, the registered incidence rate of CRC is 38 cases per 100 thousand population, which is in line with European and global trends[5]. In the CIS countries, over past 20 years, colon cancer has moved from 6th to

3rdplace in women after breast and ovarian cancer and to 3rd place in men, staying behind lung and prostate cancer.

To date following risk factors for colorectal cancer have been identified: patient older than 50, dietary habits, genetic syndromes (diffuse familial polyposis, Gardner-Turner syndrome, Peitz-Egers syndrome), Turk's disease, presence of the colon adenomas, ulcerative colitis, Crohn's disease, a history of CRC in relatives, previous breast cancer and/or female genital cancer[12].

In patients with chronic inflammatory diseases of the rectum, especially with ulcerative colitis, the incidence of rectal cancer is significantly higher than in the general population[13].

The duration and clinical course of the disease affect the risk of cancer. According to the literature[5], the risk of rectal cancer with a disease duration of up to 5 years ranges from 0 to 5%, up to 15 years - 1.4-12%, up to 20 years - 5.4-20%, up to 30 years –up to 50%.

Polyps most often occur on the background of hyperplastic folds. Lymphomas occur in the distal small intestine and cecum.

Polyps are more common in men (60%) and less often in women (40%). The sizes at which the polyps are identified as malignant: less than 5 mm - 0%, 5-9 mm - 1%, 10-20 mm - 10%, more than 20 mm - 40-50%.

Existing techniques do not always allow us to establish the nature of the changes in the colon. For example, single contrast irrigoscopy can detect only large polyps and, in 80% of cases, colon cancer is most often exophytic, less often endophytic (70-75%). Currently performed blood traces test, according to the literature, are characterized by very low sensitivity and low specificity. Colonoscopy is not always indicated for everyone and has common complications.

Foreign authors propose to conduct a virtual colonoscopy and immediately carry out fibrocolonoscopy to remove polyps identified using virtual colonoscopy.

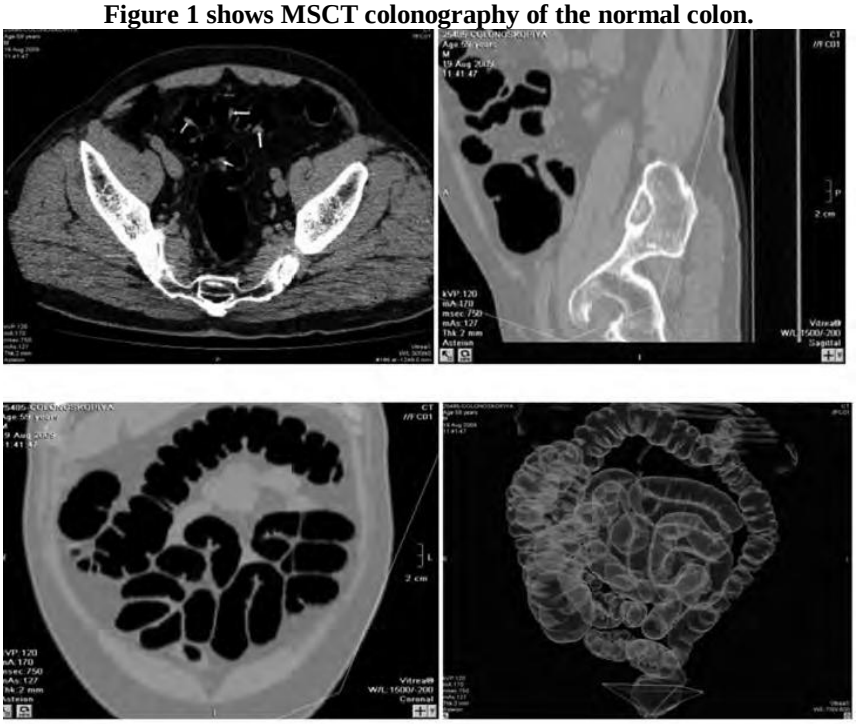
Virtual colonoscopy (screening of colon cancer using computed tomography) finds 90% of large precancerous polyps[9]. The current study showed that virtual colonoscopy detected 90% of polyps with a diameter of 10 mm or more (the same accuracy as for colonoscopy).

The purpose of this study is to establish MSCT criteria for infiltrating and exophytic colon cancer; to establish the capabilities of DWI and PET/CT in the diagnosis of colon cancer; determining the reliability of detecting polyps using MPR, 3D reconstruction and virtual endoscopy; establishing the distinctive features of MSCT images of polyps and polypoid thickening of mucosal folds; establishing criteria for tumor invasion of the intestinal walls; determining the effectiveness of chemoradiation and surgical treatment; determining radiological criteria for tumor recurrence.

II. Material And Methods

Current retrospective research is based upon multiple studies including our own, for the period from 2006 to 2017. MSCT colonoscopy was performed in 345 patients (240 with suspected cancer, 105 with polyps). Patients underwent standard preparation. The usual radiation dose for MSCT colonoscopy is 6-12 mGy. During screening, it is possible to reduce the dose to 3-6 mGy ("low dose technique"). The low dose technique should be used to determine the colonoscope obstruction cause or in case performing irrigoscopy is not possible. The contrast medium is often required to envelope the pebble poop. This is especially important for elderly people who cannot properly prepare for the examination. Intravenous administration of contrast is performed according to indications, especially if there is tumor relapse suspicion, progression of the tumor to pericolic fat, or assessment of the effectiveness of radiation or chemotherapy. When using axial imaging, it is better to use the pulmonary window, which allows better visualization of polyps. The soft tissue window better visualizes fat involvement. It is recommended to use all three projections: axial, sagittal and coronary, in good resolution (see Fig. 1).

Figure 1 shows MSCT colonography of the normal colon.



When using a 3D view, we clearly visualize invisible lesions located behind the haustral folds. Sometimes difficulties arise when there is a lot of fluid or stool. In these cases, it is necessary to examine patients on the back. With the help of targeted navigation, it was possible to inspect the large intestine both from the out-side and to view the object from the inside[9].

We used standard abdominal radiography, MSCT (multispiral computed tomography), MRI (magnetic resonance imaging), DWI (diffusion-weighted images).

MSCT studies were carried out on 4 and 64-slice Toshiba devices. MRI examinations were performed with a field strength of 1.5T PET/CT were performed using labeled 18F-FDG (2-fluorodesoxyglucose).

III. Results and Discussion

Malignant tumors are subdivided into endophytic or infiltrative, exophytic and mixed tumors. In infiltrative tumors, thickening of the colon walls over 12-13 mm was determined while 2-3 mm is normal. The latter circularly narrow the intestinal lumen.

The virtual colonoscopy clearly reveals the tumor formation. MSCT examination of the colon was carried out in cases of suspicion of a tumor and difficulty in per-forming standard methods of examination of the colon, due to severe pain, clinically manifested dolichosigma, enema incontinence, the impossibility of examining the right sections of the colon, post-radiation changes, suspicion of early postoperative complications, in cases of massive extraorganic growth to assess the prevalence of the process and identify extraorganic tumor recurrence.

Exophytic cancer was found in 90, endophytic in 86 and mixed in 74 patients. With exophytic tumors, a malignant tumor has a bumpy surface and consists of several nodes. The use of CT colonography helps to identify tumor invasion of the intestinal wall and the surrounding fatty tissue or mesentery.

Figure 2 shows an infiltrative tumor with concentric narrowing of the intestine.

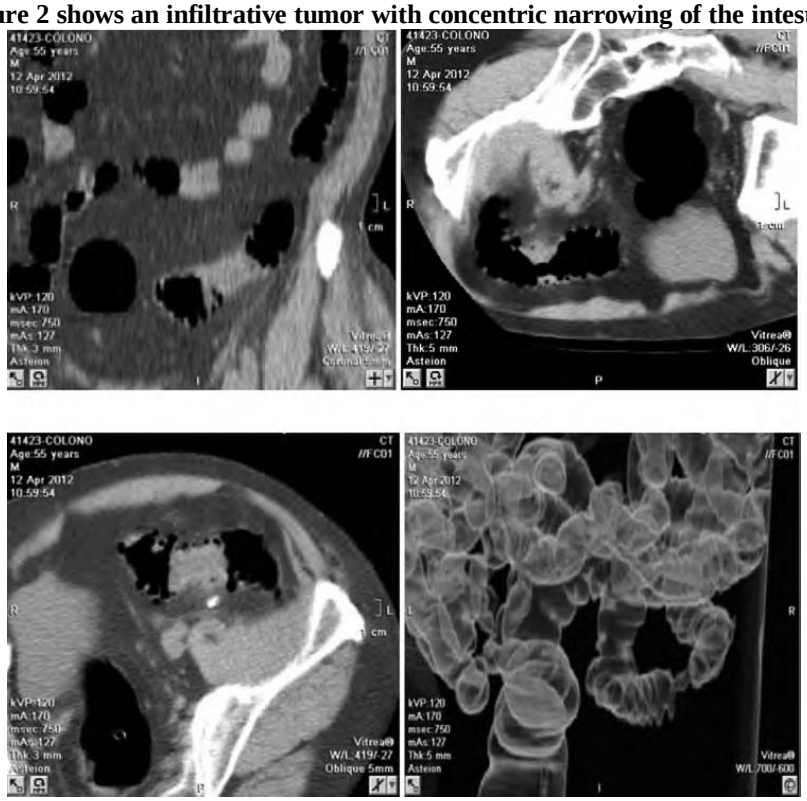


Figure 3. MSCT and spiral colonography show an exophytic colon tumor (see arrows).

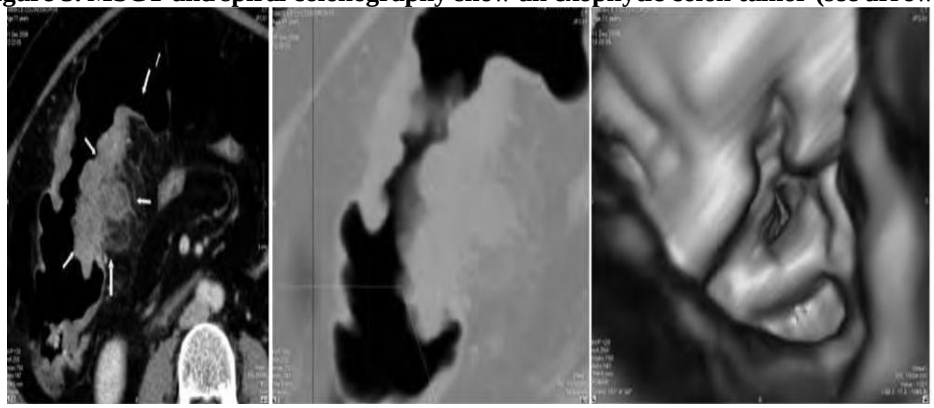


Figure 4. MSCT. Tumor of the cecum with metastases in the abdominal cavity

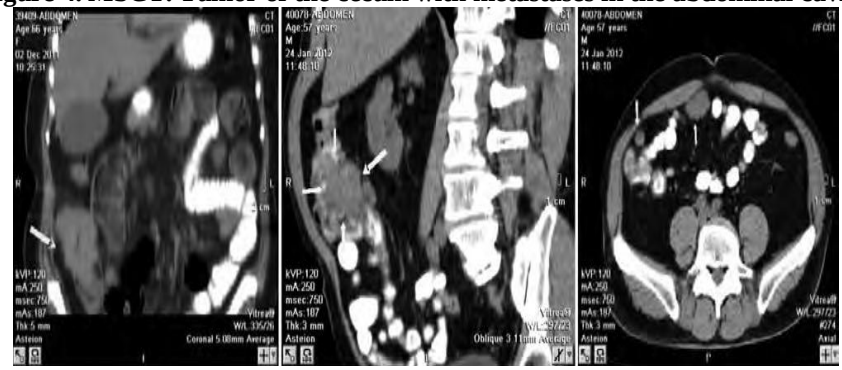
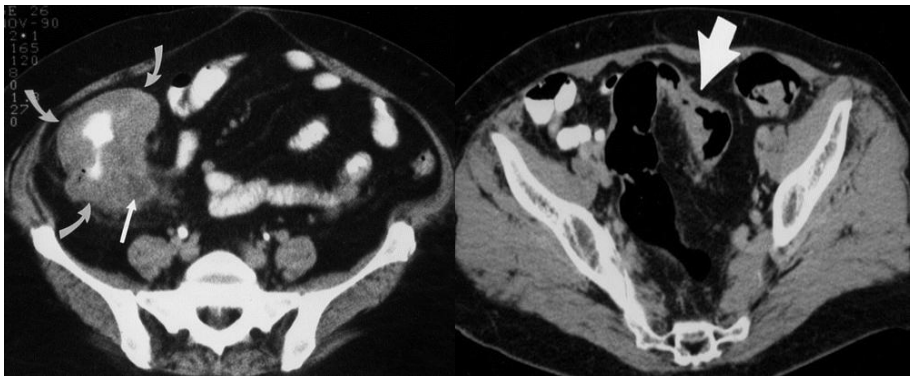
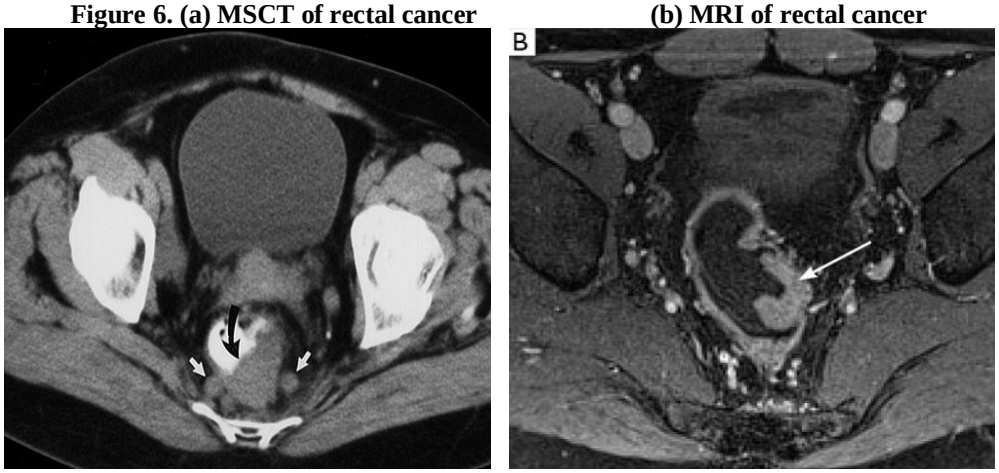


Figure 5. MSCT of colon cancer (cecum, transverse colon - arrows).



In patients with chronic inflammatory diseases of the rectum, especially with ulcerative colitis, the incidence of rectal cancer is significantly higher than in the general population. Cancer risk is influenced by the duration and clinical course of the disease (Fig. 6).

Figure 6. (a) MSCT of rectal cancer **(b) MRI of rectal cancer**



The accuracy of MSCT varies significantly and depends on the extent of the process. Here it should be noted that with the progression of the process, tumor growth can be observed not only around the anastomosis, but also in the adjacent areas, while the tumor significantly accumulates contrast. Condition of the regional lymph nodes is also worth consideration. In addition, air bubbles are al-ways detected above the feces, and there is no accumulation of contrast.

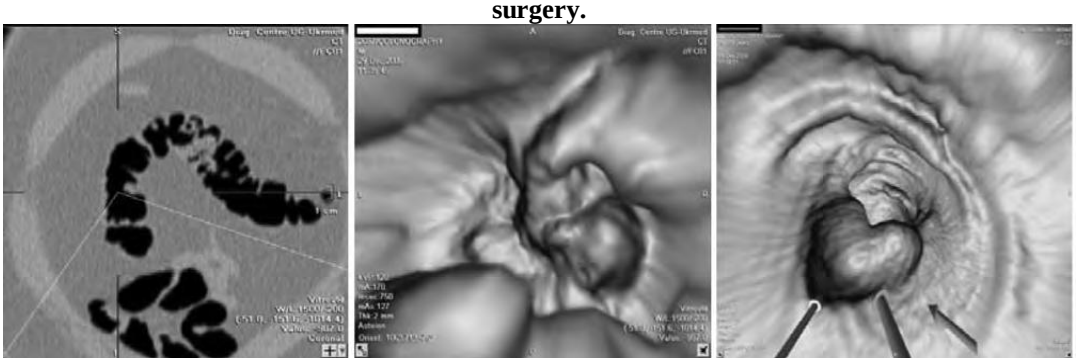
Colon polyps

In Figure 7, two polyps are found in the shadow projection option. One of them is in the hepatic corner of the large intestine, and the other on the lateral wall of the rectum. The size of the first polyp is 1.6 cm, the second is 1.5 cm.

In addition to polyps, hyperplastic folds, which resemble adenomatous polyps, are false in the differential diagnostic plan.

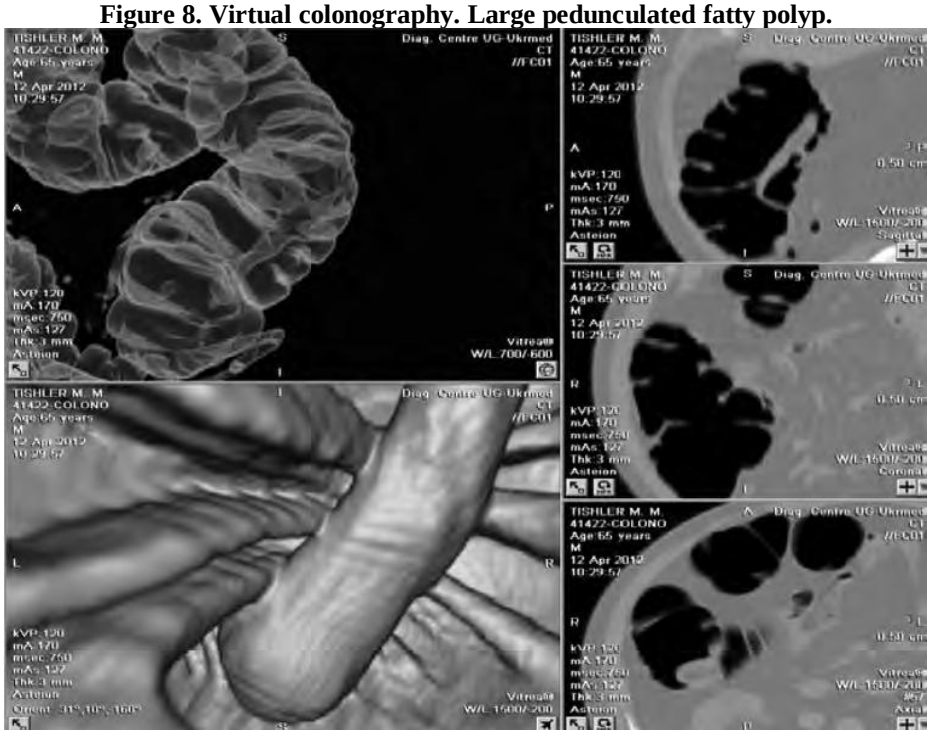
With adenomatous polyps, virtual colonography gives a clear idea of the presence of an adenomatous polyp by maintaining a normal internal pattern of the intestine, haustration (Fig. 7).

Fig. 7 shows two adenomatous polyps of different sizes: 1.6 cm and 1.5 cm. The patient was suggested for surgery.



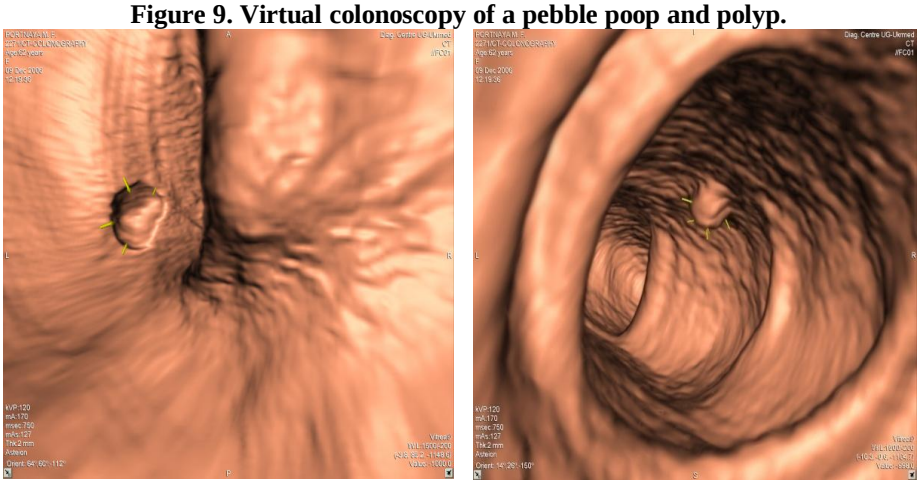
Tumor formations larger than 1 cm and hyperplastic masses in 10-25% may be carcinomas.
On an axial scan, the changes are no different from the image of cecum cancer with invasion of pericolic fatty tissue. Virtual colonography indicates an inflammatory process with preservation of gaustration. Patients with these processes must necessarily be examined using fibrocolonoscopy to take a biopsy.
Fatty polyps, especially pedunculated polyps, are highly mobile which makes them more difficult to interpret. Figure 8 shows an image of a large fatty polyp with a long stem, up to 1.8 cm in size. The polyp was removed during a subsequent colonoscopy.

Figure 8. Virtual colonography. Large pedunculated fatty polyp.



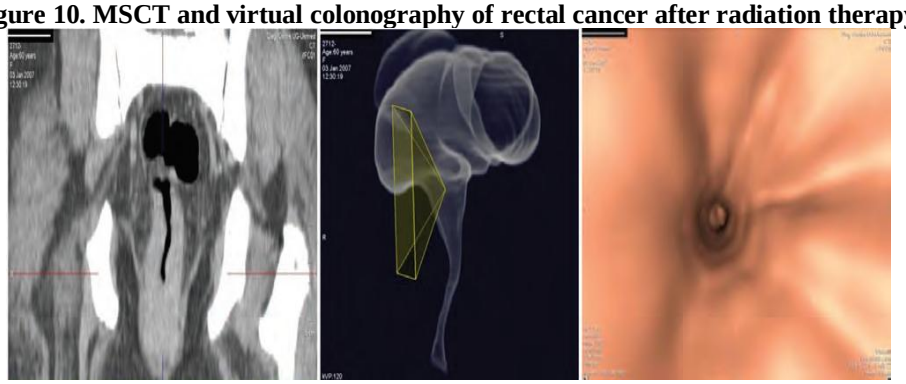
The sensitivity of MSCT in the diagnosis of polyps measuring 6 mm is 90% and 99% during colonoscopy. With tumors larger than 1 cm, the sensitivity of both methods reaches 100%, but it should be considered that not all patients will be able to undergo colonoscopy.

Figure 9. Virtual colonoscopy of a pebble poop and polyp.



When performing radiation therapy, we paid attention to the features of the contrast distribution in the tumor and surrounding tissues (during and after) irradiation. A pronounced decrease in the accumulation of contrast by the tumor indicated a good effect of the radiation therapy.

Figure 10. MSCT and virtual colonography of rectal cancer after radiation therapy.



The following are the results of examining patients using DWI and PET / CT.
DWI is based on the registration of changes in the nature of the Brownian motion of water molecules in various pathological processes. We measured the signal in-tensity in a series of DWI images and calculated the diffusion coefficient (DC) values. The ICD is a gradient curve that is plotted by comparing the values of b on the x-axis and the logarithm of the tissue signal on the y-axis. ICD values were determined automatically by entering the area of interest on the map. ICD is expressed in μm2 / s. We used the values b = 50s / mm2, 400s / mm2, 800s / mm2. For each focus, the diffusion coefficient of ICD was determined on special ICD maps (Fig. 11 and Fig12).

Figure 11. MSCT tumor of the sigmoid colon. T2-weighted images show a well-defined lesion in the perisigmoid space. DWI was obtained at b = 750 and shows a high signal.

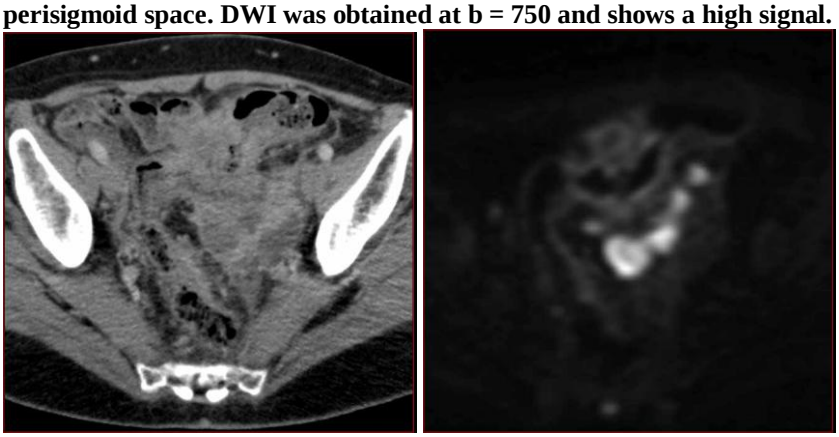
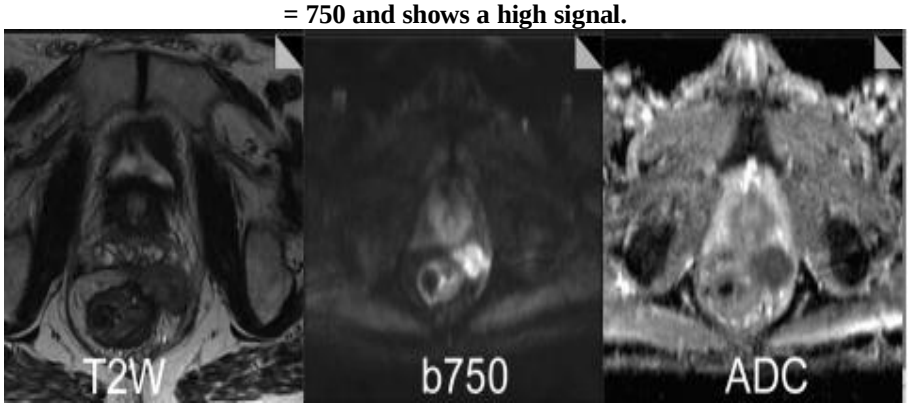


Figure 12. T2-weighted images show a well-defined lesion in the perirectal space. DWI was obtained at b = 750 and shows a high signal.



PET/CT in combination with MSCT with high accuracy allows diagnosing both small colon tumors and metastases, including tumor dissemination along the peritoneum[15] (Fig.13 and Fig.14).

Figure 13. PET/CT of rectal tumor with liver metastasis (arrows).

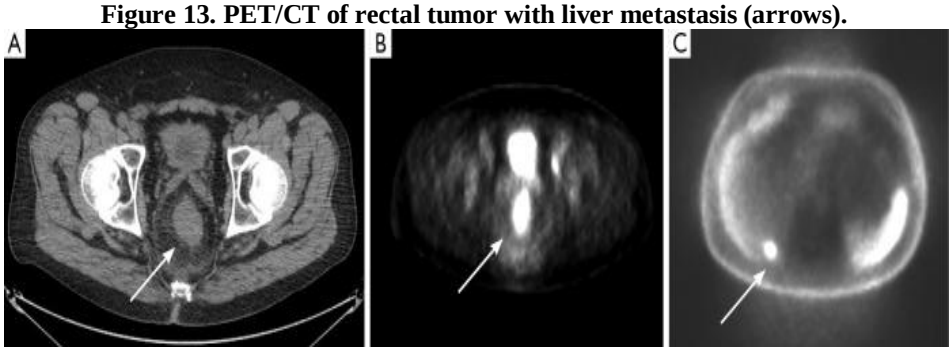
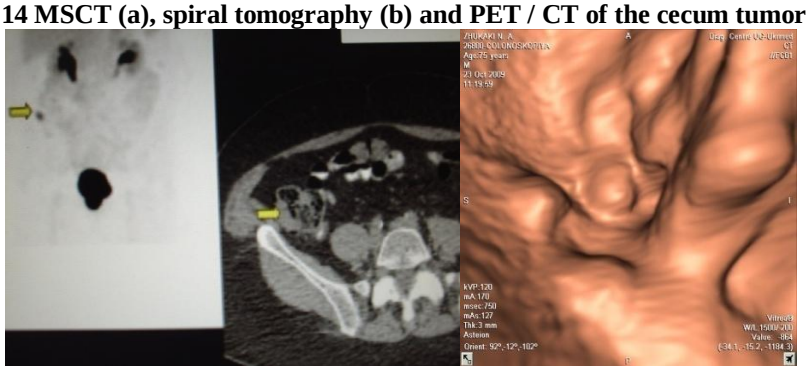


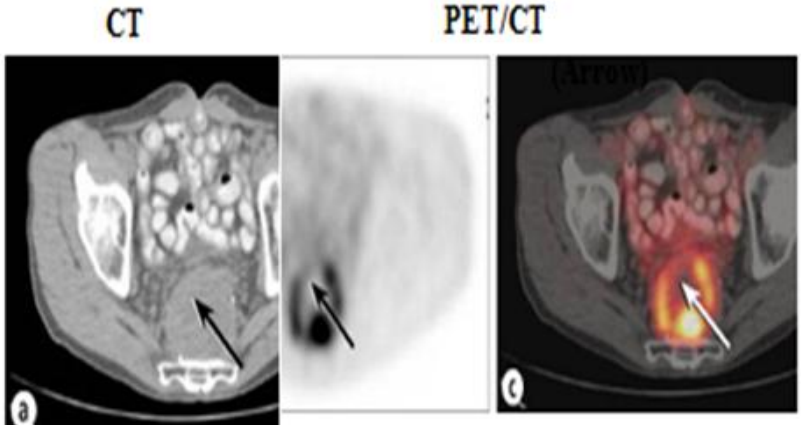
Fig. 14 MSCT (a), spiral tomography (b) and PET / CT of the cecum tumor (c).



(c) (a) (b)

Spiral tomography clearly shows tumor growths in the cecum (b), MSCT shows a tumor lesion of the cecum (arrow (a)), which was confirmed by 18F- FDG(c).

Fig. 15 MSCT and PET / CT Recurrent rectal cancer. (a) MSCT shows a large pre-sacral mass that showed negative biopsy. The negative result was obtained because during the puncture the needle passed through necrotic changes in the tumor. (b) The arrow shows the progress of the biopsy image of a fused active tumor with a discontinuous rim surrounding the necrotic center. (c) Repeated biopsy based on PET / CT imaging confirmed tumor recurrence. Rectal cancer recurrence within 6 months after surgery and radiation therapy (arrows). The accumulation of FDG over the tumor indicated insufficient effectiveness of the radiation therapy.



IV. Conclusion

MSCT, including MSCT endoscopy, is a highly informative method for detecting invasive colon cancer, showing sensitivity and specificity indicators approaching to 100%, that may not be extended to colon polyps' diagnosis (76%). Use of MSCT can increase the accuracy of preoperative detection of a colon tumor, clarify the stage of the disease, detect tumor recurrence, and determine the effective-ness of radiation therapy. The sensitivity of MSCT for detecting polyps of 5-6 mm in size was 59%, with optical colonoscopy - 76%, the sensitivity of MSCT for detecting polyps >10 mm was 91%, with optical colonoscopy - 95%.

The advantage of virtual colonoscopy is that it does not require complex preparation of the patient for the study and does not injure them, since this method is, in fact, variant of computed tomography. This technique is well suited for screening patients from risk groups, especially in the presence of polyps, because they often undergo malignant transformation.

MSCT, DWI, MRI are useful in the diagnosis and definition of the metastatic focus of neoplasm.

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