CT techniques for colorectal imaging.

Poster No.: C-0712
Congress: ECR 2017
Type: Educational Exhibit
Authors: A. Galletto¹, L. Bacigalupo², F. Paparo¹, M. Revelli³, R. Sartoris¹, G. A. Rollandi²; ¹Genova/IT, ²Genoa/IT, ³Sarzana/IT
Keywords: Inflammation, Cancer, Contrast agent-other, Computer Applications-Virtual imaging, Colonography CT, CT, Colon, Abdomen
DOI: 10.1594/ecr2017/C-0712

Any information contained in this pdf file is automatically generated from digital material submitted to EPOS by third parties in the form of scientific presentations. References to any names, marks, products, or services of third parties or hypertext links to third-party sites or information are provided solely as a convenience to you and do not in any way constitute or imply ECR's endorsement, sponsorship or recommendation of the third party, information, product or service. ECR is not responsible for the content of these pages and does not make any representations regarding the content or accuracy of material in this file.
As per copyright regulations, any unauthorised use of the material or parts thereof as well as commercial reproduction or multiple distribution by any traditional or electronically based reproduction/publication method ist strictly prohibited.
You agree to defend, indemnify, and hold ECR harmless from and against any and all claims, damages, costs, and expenses, including attorneys' fees, arising from or related to your use of these pages.
Please note: Links to movies, ppt slideshows and any other multimedia files are not available in the pdf version of presentations.
www.myESR.org
Learning objectives

To give a brief overview of the four principal techniques most commonly employed in the study of the colon: virtual CT colonoscopy (CTC), water enema CT of the colon with and without intestinal preparation (WECT), water enema CT of the colon associated to CT enterography of the small bowel (WECT + ENTERO-CT), colon CT after diluted iodinated contrast media water enema with or without bowel preparation (CTDICE). To describe in detail the technical features of each protocol as well as the different and specific clinical indications.
Background

The large bowel can be easily studied with CT to evaluate benign and/or malignant diseases (particularly colo rectal cancer CRC). An adequate large bowel lumen distension is necessary. Incomplete luminal distension may cause false positive and false negative findings, especially regarding malignant lesions.

In the past, the evaluation of the large bowel was performed with single or double (with air) contrast barium enema [1,2,3].

Single and double contrast barium enema allowed a limited assessment of the bowel lumen. The introduction of CT in the study of the bowel led to the evaluation of the whole bowel wall in cross section and of the whole abdomen in one single exam.

Different types of CT techniques have been developed; each technique with it’s own advantages and weaknesses. It is therefore mandatory that the radiologist knows the different techniques, tailoring each one to different clinical indications.

In our work, we will present and discuss the main (in our opinion) techniques: virtual CT colonoscopy (CTC), water enema CT of the colon with and without intestinal preparation (WECT), water enema CT of the colon associated to CT enterography of the small bowel (WECT + ENTERO-CT), colon CT after water enema with diluted iodinated contrast media, with or without bowel preparation (CTDICE).
Findings and procedure details

**Virtual colonoscopy CT**

Colon-rectal cancer (CRC) is one of the main causes of mortality and morbidity in the western world. CRC is commonly regarded as the end of a multiphasic process, where subsequent genetic mutations sum up and the normal epithelium becomes cancer, in a variable delay of time. Symptoms can often present in an advanced phase of disease [4].

The carcinogenic pathway is well known and population screening is crucial in early diagnosis.

Widespread screening for CRC may be done with faecal occult blood tests.

Optical colonoscopy is the gold standard in the diagnosis of CRC, but has some limitations. About 6 to 26% of optical colonoscopies are incomplete.

Virtual colonoscopy (CTC) represents a fast, and less invasive alternative to colonoscopy, with less risks. CTC is also usually more accepted by the patients. CTC is effective in the depiction of large bowel lesions and is a good gatekeeper to optical colonoscopy. Therefore, optical colonoscopy may be reserved only to patients with known or suspected bowel wall lesions, which may necessitate biopsy and/or resections [5].

Since 2008 CTC is accepted from American Cancer Society as screening test for CRC.

Among the different indications for CTC those that are more accepted are:

* Incomplete optical colonoscopy (especially in patients with low pre-test probability of CRC)

* Contraindication for optical colonoscopy or patient's refusal to do it.

* Follow-up of CRC surgery

* CRC screening

The main contraindications to CTC are recent surgery (<3 months) and active inflammatory bowel diseases.

In CTC intravenous iodinated contrast media administration is not mandatory (although iodinated contrast media is usually used for fecal tagging) and usually not performed.

Among the technical aspects the main is adequate bowel preparation with a low fiber diet in the three days before the exam and cathartic drug administration the night before.
Oral iodinated contrast media is administered for fecal tagging in CTC, this allows to easily differentiate true bowel lesions from feces/liquid (Fig. 1 on page 9).

In CTC the large bowel is usually distended with air or CO2.

If possible intravenous drugs (usually Buscopan) are used to reduce intestinal peristalsis and obtain a better large bowel distention.

CTC exams should be performed with a multislice (at least 16 detectors) CT, with small thickness images for adequate reconstructions, using a low dose scan protocol (\(\leq 120\) kV and \(\leq 50\) mAs). The CT scans have to be performed both in the prone and supine position.

Images are then evaluated in 2D and with dedicated softwares that allow 3D endoluminal reconstructions. Modern softwares include also different types of CAD (Computer Aided Detection) tools.

**Tips and Tricks**

Always check (with low dose CT) colon distention before you perform CTC after a failed optical colonoscopy in the same day, overinsufflation is a risk in these patients. If possible CTC should be reprogrammed the following day or after an adequate time delay to allow for Faecal tagging.

It is also recommended to check for free air after a failed optical colonoscopy before performing CTC.

**Water enema CT**

This technique is based on the large bowel distension with water, followed by intravenous contrast administration. This leads to an excellent visualization of the bowel wall due to contrast enhancement and to a superb contrast between bowel walls, water filled lumen and fat/peri-colic structures.

Also for water enema CT, adequate intestinal preparation is mandatory, achieved by low fiber diet three days before the exam and a cathartic drug administration the day before (for example poliethilenglicole, Isocolan).

Water enema CT is performed distending the large bowel with the warm water enema, then antiperistaltic drugs may be injected intravenously (i.e. buscopan) and finally the iodinated contrast media is injected intravenously. With water enema CT the CT study can be tailored to the patient; in the majority of cases only one scan in the portal phase in the supine position is enough. In case of diagnostic doubts regarding the differentiation between parietal lesion and faecal residues a further scan in the prone position or another scan in a late phase in the supine position can be added (Fig. 2 on page 9, Fig.
Density measurement of faecal residues can also be useful (Fig. 4 on page 11). The CT scan can be also used to assess completely other types of pathology apart of the large bowel, the CT protocol can be tailored to allow as well: liver, pancreas, kidneys.

Furthermore in CRC cancer staging a CT of the thorax is usually added providing a reliable baseline for all the following CT scans and a complete staging.

Water enema CT in our opinion should be the exam of choice in patients with a high pre-test probability of CRC. Water enema CT with CT of the thorax allows a timely and cost effective staging of CRC (6).

CRC is not the only indication of water enema CT. It can be successful employed in the study of patients with inflammatory chronic disease, in surgical anastomosis evaluation, in diverticulitis, in the evaluation of endometriosis (7).

**Tips and Tricks**

Always check the patient CT imaging needs, water enema CT can be easily associated with complex renal cystic lesions evaluation for example.

Water enema CT without previous intestinal preparation may be used to better define the location of CRC in patients that undergo CT for CRC staging before surgery.

Water enema CT may be usefully added to patients that must be scheduled for a CT of the abdomen for any other reasons and that did not have any CRC screening test (faecal occult blood test, optical colonoscopy, CTC).

**Water enema CT of the colon associated to CT enterography of the small bowel (WECT + ENTERO-CT).**

This technique has been proposed to obtain a simultaneous distension of the small bowel and of the colon.

To evaluate the small bowel with CT the lumen should be distended. In WECT + ENTERO CT we distend the lumen orally with, for example, Isocolan (CT enterography, Fig. 5 on page 11).

A naso-jejunal tube (CT enteroclysis, Figure 6) can also be used.

The hypodense distention of the small bowel allows a good assessment of the small bowel walls following intravenous iodinated contrast administration (8,9).

Crohn disease is one of the commonest indications for WECT + ENTEROCT (Figure 5).
In Crohn disease WECT + ENTERO CT allows assessment of localisation and disease behaviour (inflammatory, stenosing or penetrating) (10,11).

WECT + ENTEROCT can also be employed in other pathologies such as occult digestive bleeding, small intestinal cancers (Fig. 6 on page 12), and Meckel's diverticula.

As for WECT an adequate intestinal preparation is mandatory to perform the exam: three day before low fiber diet and purgative drug the day before the exam.

To obtain the small bowel distention approximately 1.5ml of PEG (poliethilenglicole, Isocolan for example) is administered to the patient in about 20 minutes.

After other 20 minutes, the patient is positioned in the scan room and the large bowel is distended with the water enema. Intestinal motility inhibitor drugs (Buscopan for example) are usually administered intravenously. The CT protocol can and must be tailored to each patient: in the majority of cases a unique portal phase in the supine position is adequate, when a small bowel tumor is suspected an arterial phase and late phase are usually mandatory.

**Tips and Tricks**

It is important to check if the patient had any small bowel resection that can reduce the time needed between when the patient finishes to drink the PEG and the CT scan.

**Colon CT after diluted iodinated contrast media water enema, with or without bowel preparation (CTDICE)**

This technique uses a water enema with diluted iodinated contrast media.

The most common indications are: post colo rectal surgery evaluation in case of suspected fistulas (Fig. 7 on page 13, Fig. 8 on page 14, Fig. 9 on page 14, Fig. 10 on page 14, Fig. 11 on page 15), assessment of perforated diverticulitis (12). In these cases bowel preparation is not performed.

Another promising field of application of CTDICE is in the elderly and/or fragile patients. In these patients CTDICE allows the assessment of the large bowel without intravenous contrast media administration (particularly useful when the creatinine clearance is poor) after bowel preparation. In some cases CTDICE can be used as an alternative to CTC even after faecal tagging with iodinated contrast media; in some patients CTC may be requested but the patient may not be able to maintain the prone position, in these patients CTDICE can be used (Fig. 12 on page 16).

Moreover, in old and "fragile" patients a CTDICE can be performed even without intestinal preparation.
Intravenous contrast media can be used after CTDICE in those patients were a CRC is depicted and full staging of the abdomen is needed.

Liedenbaum proposed CTDICE in 2009 in colon rectal cancer screening and in evaluation of patient with occult bowel bleeding (13). CTDICE may be even used for CRC screening in asymptomatic patients without the need of intestinal preparation (14, 15).

**Tips and Tricks**

When used as an alternative to WECT (usually in patients with a poor renal function) CTDICE is usually performed in both the supine and prone position (Fig. 13 on page 17).

In patients with suspected fistula of low colo rectal anastomosis CTDICE trough ileostomy (if present) has to be preferred to avoid any trauma to the surgical anastomosis (Fig. 11 on page 15).

In some cases, enterography with water and diluted contrast media can be associated to CTDICE (Fig. 14 on page 17) to obtain an evaluation also of the small bowel, this may be particularly useful in old patients with a poor renal function (especially if MRI contraindications are present) and occult intestinal bleeding.
Fig. 1: Figure 1. Virtual colonoscopy performed in the afternoon after incomplete optic colonoscopy interrupted at the sigma due to adherences in the early morning. Oral contrast media has been administered to achieve fecal tagging. The virtual colonoscopy is negative; no lesions have been revealed in the subsequent (three years after) optic colonoscopy, performed in deep sedation. Virtual colonoscopy can be employed to complete an incomplete optical colonoscopy, also in the same day, avoiding the patient to repeat intestinal preparation

© - Genova/IT
Fig. 2: Figure 2. 79 y/o patient. Two polypoid lesions of the sigma and a small vegetating lesion of the posterior ascending colonic wall, difficult to appreciate due to minimal fecal residues. In the same contrast enhanced CT exam it is possible to evaluate the liver: some cysts were present, no suspected lesions were depicted. The patient was threatred successfully endoscopically.

© - Genova/IT
**Fig. 3:** Figure 3. Female patient, 65y old, scheduled for CT for undetermined lesions depicted at US. WECT was associated since the patient had done no screening for CRC. Small fecal residue that moves from supine to prone.

© - Genova/IT

**Fig. 4:** Figure 4. Female patient 70y old. WECT for assessment of the colon associated to liver evaluation following US that depicted right adrenal nodule and liver lesion (adenoma and hemangioma, not shown). Small fecal residue that shows no contrast enhancement and has stable HU.

© - Genova/IT
**Fig. 5:** Figure 5. Coronal reformatted CTe-WE image showing simultaneous distension of ileum (i), caecum (C) and ascending colon (ac). Note collapsed jejunal loops (J) in the left upper abdominal quadrant.

Fig. 6: Figure 6. Volume-rendered CT reconstruction (A) and coronal reformatted CTE image (B) which show the position of the nasojejunal enteroclysis catheter (arrows) with the tip at the duodenojejunal passage. The optimal distension of jejunal loops (J) is well appreciable in B.

**Fig. 7:** Figure 7. Female patient 75y old. Low rectal cancer before surgery. At CT and MRI T2, N0 confirmed at surgery.

© - Genova/IT

**Fig. 8:** Figure 8. Same patient as Figure 7 following surgery (TME). Traditional conventional radiography anastomosis study with iodinated contrast media opacification from the ileostomy. Irregular shape of the anastomosis on the right (arrow in A and B) and posterior sides (arrow in C). The diverticula proximal to the anastomosis are a confounding factor.

© - Genova/IT

**Fig. 9:** Figure 9. Same patient as Figures 7 and 8. Following the radiographic study given the unclear findings CT was performed. First CT without any contrast media in acquired (A) and shows (arrow in A) extraluminal gas on the posterolateral right side cranial to the anastomosis. Following diluted contrast media enema (CTDICE) injection through the ileostomy opacification of the anastomosis is obtained and contrast media is appreciated extraluminally confirming the presence of an intestinal perforation. In this case a small perforation of a colon diverticula immediately cranial to the anastomosis was diagnosed.

© - Genova/IT
Fig. 10: Figure 10. Same patient as Figures 7-9. Following 3 weeks a new CT without iodinated contrast media and a CTDICE through the ileostomy are obtained. No perforation is appreciated and the patient underwent after one week successfully ileostomy closure.

© - Genova/IT
**Fig. 11:** Figure 11. Same patient as Figure 7-10. It is important to underline that when a low rectal anastomosis was performed opacification of the anastomosis is recommended through the ileostomy (if present).

© - Genova/IT
Fig. 12: Figure 12. CTDICE is a possible alternative to WECT in older patients with poor renal function and unable to undergo CTC. In these cases, significant colorectal stenotic lesions can be ruled out. Smaller lesions are more difficult to assess especially when the bowel cleansing is incomplete with multiple fecal residues (arrows in A and B).

© - Genova/IT

Fig. 13: Figure 13. 81 years old male. In patients scheduled for WECT but with a poor renal function CTDICE is a valid last minute alternative to assess the patient without rescheduling the CT (scheduling a CTC for example). In these cases, it is usually possible to acquire both supine and prone images to better differentiate colon lesions from fecal residues (Arrows in A and B) as in CTC.

© - Genova/IT
Fig. 14: Figure 14. In patients scheduled for WECT+ENTERO CT but with a poor renal function CTDICE+ Small bowel enterography with diluted contrast media is an interesting alternative. Especially in older patients unable to undergo MRI. This technique allows an adequate assessment of the small bowel and of the colon to rule out significant lesions.

© - Genova/IT
Conclusion

There are many different types of large bowel pathologies, that may be associated to other related or unrelated conditions of the abdomen and/or thorax.

The radiologist can tailor the assessment of each patient with the right CT technique and its variations.

In our experience, we follow these main criteria (Fig. 15 on page 20):

- CTC for screening and/or following incomplete optical colonoscopy in the asymptomatic patient.

- WECT is preferred in the symptomatic patient (to evaluate/rule out CRC and chronic inflammatory bowel disease). WECT may precede optical colonoscopy in patients with high suspicion of CRC to guide optical colonoscopy (right colon cancer in patients with known pelvic adhesions).

- WE+ENTEROCT is chosen to evaluate/rule out: Crohn disease, occult intestinal bleeding, intestinal tumors of the small and large bowel.

- CTDICE is used in the evaluation of: surgical anastomosis, suspected perforation of diverticula, old/fragile patients as an alternative to WECT and CTC.
### Table 1. An overview of the main imaging techniques for the colon.

<table>
<thead>
<tr>
<th>Method</th>
<th>Intestinal preparation (3 day diet and bowel cleansing)</th>
<th>Fecal tagging with iodinated contrast media</th>
<th>Small bowel enterography per os with PEG (Isocolon)</th>
<th>Intravenous iodinated contrast media</th>
<th>Main indications</th>
</tr>
</thead>
<tbody>
<tr>
<td>CTC</td>
<td>YES</td>
<td>YES (allergy risk)</td>
<td>NO</td>
<td>Optional</td>
<td>Asymptomatic patients</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Incomplete optical colonoscopy</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Alternative to optical colonoscopy</td>
</tr>
<tr>
<td>Water enema CT</td>
<td>YES</td>
<td>NO</td>
<td>NO</td>
<td>YES</td>
<td>Symptomatic patients</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Before or after optical colonoscopy (also after incomplete optical colonoscopy)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>CRC staging</td>
</tr>
<tr>
<td>Water enema CT + EnterocoCT</td>
<td>YES</td>
<td>NO</td>
<td>YES</td>
<td>YES</td>
<td>Symptomatic patients</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Crohn</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Occult intestinal bleedings</td>
</tr>
<tr>
<td>CTDICE</td>
<td>YES if possible</td>
<td>Optional</td>
<td>NO</td>
<td>NO</td>
<td>Symptomatic patients</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Old/fragile patients</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Patients with renal insufficiency</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Possible alternative to CTC in fragile patients</td>
</tr>
<tr>
<td>CTDICE</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>Optional</td>
<td>Fistulae assessment</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Assessment of diverticula perforation</td>
</tr>
</tbody>
</table>

**Fig. 15:** Table 1. An overview of the main imaging techniques for the colon.

© - Genova/IT


