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The second ESGAR consensus statement on CT colonography

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Abstract
Objective To update quality standards for CT colonography based on consensus among opinion leaders within the European Society of Gastrointestinal and Abdominal Radiology (ESGAR).
Material and methods A multinational European panel of nine members of the ESGAR CT colonography Working Group (representing six EU countries) used a modified Delphi process to rate their level of agreement on a variety of statements pertaining to the acquisition, interpretation and implementation of CT colonography. Four Delphi rounds were conducted, each at 2 months interval.
Results The panel elaborated 86 statements.

In the final round the panelists achieved complete consensus in 71 of 86 statements (82 %). Categories including the highest proportion of statements with excellent Cronbach's internal reliability were colon distension, scan parameters, use of intravenous contrast agents, general guidelines on patient preparation, role of CAD and lesion measurement.

Lower internal reliability was achieved for the use of a rectal tube, spasmolytics, decubitus positioning and number of CT data acquisitions, faecal tagging, 2D vs. 3D reading, and reporting.
Conclusion The recommendations of the consensus should be useful for both the radiologist who is starting a CTC service and for those who have already implemented the technique but whose practice may need updating.

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Key Points

- *Computed tomographic colonography is the optimal radiological method of assessing the colon*
- *This article reviews ESGAR quality standards for CT colonography*
- *This article is aimed to provide CT-colonography guidelines for practising radiologists*
- *The recommendations should help radiologists who are starting/updating their CTC services*

Keywords CT colonography · Guidelines · Computed tomography · Colon · Polyps

Introduction

Since its introduction (in 1994) [1], clinical implementation of computed tomography (CT) colonography has been governed by advances in CT technology, improvements in dedicated analysis software, development of patient preparation regimens and local diagnostic policies.

In 2007 the European Society of Gastrointestinal and Abdominal Radiology (ESGAR) consensus statement on CT colonography was published, detailing how best to conduct and interpret the examination [2]. That document was based on collective experience up to the beginning of 2006, and the authors represented the EU countries in which CTC underwent consistent clinical implementation (UK, Italy, Belgium and The Netherlands). Over the last 5 years expansion of the CT colonography literature has continued and several important studies, including multicentre studies, have been published [3–5]. These new data have provided further insight regarding optimisation of the CT colonography technique, interpretation and diagnostic capabilities. Indeed CT colonography is now recommended for colorectal cancer screening by several international groupings and is widely used to investigate patients with symptoms suggestive of colorectal cancer [6, 7]. Although recent review articles provide some guidance regarding the optimal CT colonography technique, given the evolving data [8–11] there is a current need to update the ESGAR consensus document.

The purpose of this article is therefore to update quality standards for CT colonography based on examination of the existing literature and expert opinion from key opinion-leaders within the European Society of Gastrointestinal and Abdominal Radiology.

Materials and methods

Consensus panel

A multinational European panel of nine members of the ESGAR CTC Working Group (comprising J.S., S.H., S.T., P.L., T.M., D.R., M.H., A.L., E.N., and representing six EU countries: Austria, Belgium, Italy, The Netherlands, Sweden and the UK) used a modified Delphi process [12, 13]. The Delphi process consists of a survey conducted in two or more rounds; the answers (or statements) collected in the first survey are modified in the second, the third, etc., to reach the maximum consensus among the experts. We rated the level of agreement among the experts on a variety of statements pertaining to the acquisition, interpretation and implementation of CT colonography. Four Delphi rounds were conducted, each at 2 months interval.

One of the panellists was chosen as the facilitator (E.N.).

In the first round the facilitator emailed a questionnaire with 22 items pertaining to panel members' personal approaches to CTC, including items on patient preparation, data acquisition technique, image interpretation and clinical implementation (Table 1). Responses collected from all panellists were merged into a unique datasheet that served to identify areas of agreement and conflict in panellist opinion.

In the second round, the panellists attended a 1-day, face-to-face meeting, and, on the basis of their main areas of research and expertise, were divided into four working groups (WG) as follows: bowel preparation and tagging (WG 1), insufflation and scanning protocols (WG 2), reading paradigm (WG 3) and reporting (WG 4). Each WG independently drafted a cluster of statements pertaining to their allocated subject (Table 2). Each statement was built on the basis of panelists' expertise and available indexed literature. Each WG then presented their proposed statements to the whole panel for consideration and subsequent discussion, during which time the content and wording of statements were modified until a general consensus emerged.

In the third and fourth rounds, copies of the latest statements were sent by email to panellists, who then indicated independently their level of agreement with each individual statement using a 5-point scale, as follows: 1, strongly disagree with the statement; 2, disagree somewhat with the statement; 3, undecided; 4, agree somewhat with the statement; 5, strongly agree with the statement.

After the third round the facilitator collected panellists' ratings and determined the agreement score for each statement. If the mean score for an individual item was lower than four (maximum possible=five) the facilitator asked panelists to review the statement and attempt to reach a consensus in the fourth round.

Statistical analysis

To measure the internal consistency of panellist's ratings for each statement, a quality analysis was performed using Cronbach's α correlation coefficient and SPSS (SPSS, Chicago, Ill.) [14]. Cronbach's α was determined after each round.

Table 1 Second ESGAR CT colonography consensus. Survey of the first Delphi round

Please rate your suggestions as follows (in some questions)

☐ 1	☐ 2	☐ 3	☐ 4
Do not suggest	Could suggest if no other choice	Regularly suggest	Strongly suggest

Preparation and tagging. Which would you suggest? ☐ Cathartic and no tagging ☐ Cathartic and fecal tagging ☐ Reduced laxative and fecal tagging ☐ No laxative and fecal tagging

Cleansing and tagging agents: ☐PEG / MACROGOL ☐Phosphosoda ☐Gastrografin ☐Barium alone ☐Iodine alone ☐Barium and iodine

Cleansing regimen (when to start) (1-4)

☐1 day before exam ☐2 days before exam ☐3 days before exam

Tagging regimen (when to start) (1-4)

☐Same day of the exam ☐1 day before exam ☐2 days before exam ☐3 days before exam

Insufflation and scanning protocol

Which distension agent? ☐Air ☐CO2

Who should perform the insufflation? ☐Medical doctor ☐Radiographer ☐Nurse

In which situations you would suggest the use of spasmolytics? (check all that apply):

☐ regularly, in all patients ☐ in patients where at scout view the colon appears poorly distended

☐ if patient is finding insufflation unduly uncomfortable ☐ other known diverticular disease ☐ not used

Which spasmolytics (1-4) ☐Buscopan ☐Glucagon

Which rectal tube (1-4) ☐Flexible with balloon ☐Flexible without balloon ☐Rigid with balloon ☐Rigid without balloon

CT scanner type (minimum number of rows) ☐ 1-2 ☐ 4☐ 8 ☐ 16 ☐ 32 ☐ 64 ☐ more rows

CT Low dose protocol: ☐never use ☐use only in asymptomatic patients ☐to use in both asymptomatic and symptomatic patients

CT Normal dose protocol: ☐never use ☐use only in symptomatic patients ☐to use in both asymptomatic and symptomatic patients

Intravenous contrast: ☐not used ☐used in all symptomatic patients ☐used in patients with known cancer or suspected after first series acquisition ☐always used

Decubitus (1-4): ☐Supine first and after prone ☐Prone first and after supine ☐Additional lateral decubitus

Who could read and report the exam?

☐ Radiologist alone ☐ Radiographer alone ☐ By radiographer (preliminary read) then by radiologist (verification) ☐ By resident (preliminary read) then by radiologist (verification) ☐ Other (gastroenterologist)

Which is your preferred reading paradigm?

☐ primary 2D + 3D as problem solving ☐ primary 3D + 2D as problem solving ☐ virtual dissection

Which is your preferred CAD reading paradigm? ☐ 2nd reader ☐ 1st reader ☐ concurrent reading

Who should write the report? ☐ radiologist ☐ radiographer ☐ other (gastroenterologist, etc…)

Do you follow C-RADS (CT Colonography Reporting and Data System) recommendations?

☐ yes ☐ no ☐ in some occasions (please specify)

When a <6 mm polyp is detected at CTC, what is your suggested policy?

☐ never report ☐ report only in symptomatic or high risk patients ☐ report it, but don't advise a polypectomy ☐ report it, and advise a polypectomy ☐ report it, and advise a follow up

When a 6-9 mm polyp is detected at CTC, what is your suggested policy?

☐ never report ☐ report only in symptomatic or high risk patients ☐ report but don't advise a polypectomy ☐ report and advise a polypectomy ☐ report and advise a follow up

Informed consent should be obtained? ☐ yes ☐ no

Table 2 Statements elaborated by the panellists in the second Delphi round, and discussed in the third and fourth to reach the maximum consensus and Cronbach's internal reliability. Statements with score between 4 and 5 are highlighted to show the situations in which all panellists agreed on the statement but the level of support differed (i.e. "agree somewhat" versus "agree strongly")

		Second round	Third round			Fourth round		
Cluster	**Stat. #**	**Statements**	*mean scores*	*std dev*	*Cronbach's alpha*	*mean scores*	*std dev*	*Cronbach's alpha*
Rectal tube	1	The use of thin and flexible rectal tubes is recommended (1). Rigid catheters should not be used. Inflation of a small balloon with air is optional.	5.00	.000	**0,074**	5.00	.000	**0,53**
	2	If an inflated rectal catheter balloon is used, it should be deflated in one scan acquisition to reduce the risk of masking a distal lesion.	4.78	.441		5.00	.000	
	3	Placement of the rectal tube must be performed by a practitioner specifically trained in the technique. This may be a radiologist, resident, radiographic technician or radiographic nurse, depending on local practice.	5.00	.000		5.00	.000	
	4	A digital rectal examination is not mandatory. If inflation of a rectal balloon is performed consideration should be given to digital rectal examination.	4.56	.527		4.56	.527	
Spasmolytics	5	Use of Spasmolytics (Hyoscin-N-Buthylbromide (Buscopan®)) is preferable prior colonic distension, noting specific contraindications. However, decision to administer spasmolytics should be also based on patient's history (diverticular disease, previous incomplete colonoscopy for strictures, etc).	4.78	.667	**0,124**	4.78	.667	**0,25**
	6	Hyoscine-N-butylbromide (buscopan) is the spasmoltyic of choice.	5.00	.000		5.00	.000	
	7	If spasmolytics are used, administration should be before commencing insufflation.	4.89	.333		4.89	.333	
	8	If buscopan is contraindicated Glucagon (1 mg) may be used.	4.56	.726		4.67	.500	
Colon distension	9	Automatic distension with CO2 is the method of choice, to optimize colonic distension and to maximise patient comfort	5.00	.000	**1**	5.00	.000	**1**
Method of colon distension	10	Manual distension with carbon dioxide or room air is an acceptable alternative if automated insufflations facilities are not available.	5.00	.000		5.00	.000	
	11	Colonic insufflation must be performed by a practitioner specifically trained in the technique. This may be a radiologist, resident, radiographic technician or radiographic nurse, depending on local practice	5.00	.000		5.00	.000	
Quality of colonic distension	12	Colonic distension should be sufficient such that all segments are fully visualized in at least one patient position and ideally in both.	5.00	.000	**1**	5.00	.000	**1**
	13	The volume of gas administered does not alone indicate adequate distension.	5.00	.000		5.00	.000	
	14	The optimum insufflated gas volume differs between individuals and should be judged taking into consideration colonic pressure (if measured), patient tolerance and the appearance on the scout image.	5.00	.000		5.00	.000	
	15	The degree and completeness of colonic distension should be checked by inspection of a scout image acquired in both patient positions prior to each full CT data acquisition.	5.00	.000		5.00	.000	
Image acquisition	16	A combination of supine and prone positioning is standard.	5.00	.000		5.00	.000	
Decubitus and number of CT scans	17	If the patient is unable to lie in the prone position, a lateral decubitus scan is recommended.	5.00	.000	**N/A**	5.00	.000	**0,3**
	18	If segments are inadequately visualized due to poor distension, an additional scan is indicated with further insufflation and/or in a different position.	4.78	.441		5.00	.000	
	19	There is little evidence that the order of patient positioning (ie supine or prone position first) influences distension quality.	5.00	.000		5.00	.000	
Scan parameters	20	Use of multidetector row CT scanners (= and >4 rows) is a prerequisite for CTC given the requirement to achieve a CT scan of the whole abdomen with a narrow collimation within one breath-hold.	5.00	.000	**1**	5.00	.000	**1**
	21	Maximum collimation influences colonic lesion detection and should be no more than 2.5mm, although newer generation CT-Scanners allow routine acquisition of thinner slices which is preferable.	5.00	.000		5.00	.000	
	22	Images should be reconstructed with an overlap. (20-30% overlap).	5.00	.000		5.00	.000	
	23	CT scans should be performed in cranio-caudal direction to minimize breathing artifacts.	5.00	.000		5.00	.000	
	24	Low radiation dose protocols without IV contrast should be used for screening CTC.	5.00	.000		5.00	.000	
	25	120 kV should be used for both supine and prone acquisitions, but lower kV may be acceptable in specific situations.	5.00	.000		5.00	.000	
	26	When IV contrast is not adminstered ≤ 50 mAs is preferable for prone and supine positions, excepting overweight patients.	5.00	.000		5.00	.000	
	27	Dose modulation and iterative reconstruction should be applied if available.	5.00	.000		5.00	.000	

Table 2 (continued)

IV Contrast	28	IV contrast is not required for colonic evaluation but improves evaluation of extra-colonic organs.	4.89	.333	**0,38**	5.00	.000	**1**
	29	Oral tagging agents do not preclude the use of IV contrast.	5.00	.000		5.00	.000	
	30	IV contrast should be administered in all patients with known colorectal cancer (unless contraindicated) to facilitate staging.	5.00	.000		5.00	.000	
	31	In symptomatic patients without known colorectal cancer, routine administration of IV contrast depends on the clinical indication and requirement to fully evaluate the extracolonic organs, especially if an abnormality has been seen on the unenhanced scan.	5.00	.000		5.00	.000	
	32	If IV contrast is administered, acquisition should be in the portal venous phase.	4.89	.333		5.00	.000	
	33	If IV contrast is administered a standard radiation dose protocol should be applied, although a reduced mA acquisition ≤ 50 mAs should be utilized during the unenhanced acquisition	5.00	.000		5.00	.000	
	34	If intravenous contrast media is administered, it is preferable to do so in the supine position	4.89	.333		4.89	.333	
Precautions before and after CT scan	35	Before the patient leaves the CT table, the quality of the examination should ideally be assessed by a practitioner specifically trained in the technique. Specific attention should also be made for the presence of perforation.	4.89	.333	**0,75**	4.89	.333	**0,75**
	36	If colonic perforation is a possibility, for example following difficult optical colonoscopy, this should be excluded via acquisition of "low dose" abdominal CT, before starting CTC.	4.89	.333		4.89	.333	
	37	If polypectomy has recently been performed there is a case for delaying CTC depending on the type of biopsy. There is no clear evidence regarding the interval.	5.00	.000		5.00	.000	
Patient preparation	38	General patient preparation for CTC is mandatory for proper detection of polyps and CRC in both symptomatic and asymptomatic individual. This may include dietary restriction, oral contrast agent and bowel purgation.	5.00	.000	**1**	5.00	.000	**1**
General guidelines	39	The general patient preparation scheme, including bowel purgation if used, should be straightforward and simple.	5.00	.000		5.00	.000	
	40	An information leaflet with detailed description of the preparation scheme is advised.	5.00	.000		5.00	.000	
Aggressivenes of preparation	41	Tagging regimens should be restricted to no more than 24 hours.	4.67	.707	**0,57**	4.78	.667	**0,6**
	42	Aggressive catharsis (purgation) should be restricted to 24 hours or less.	5.00	.000		5.00	.000	
	43	Bowel preparation should include dietary restrictions (e.g. Low fibre diet), to reduce faecal volume and faecal heterogeneity.	5.00	.000		5.00	.000	
	44	The bowel preparation for CTC should normally include laxative agents.	5.00	.000		5.00	.000	
	45	A trade-off between the patient burden and the required image quality to detect the target lesion should be considered when choosing a laxative agent.	5.00	.000		5.00	.000	
	46	CTC without laxative, but with tagging, may be considered in frail and elderly patients where CRC is the diagnostic target.	5.00	.000		5.00	.000	
	47	Sodium phosphate is efficient but not recommended at double dose since this may cause serum electrolyte disturbances, phosphate nephropathy.	4.67	1.000		4.67	1.000	
	48	Magnesium citrate has less side effects and should therefore be preferred over sodium phosphate. However it has restricted availability in Europe.	4.67	1.000		4.67	1.000	
	49	Polyethylene glycol preparations avoid many electrolyte disturbances, but may result in excess colonic fluid.	4.89	.333		4.89	.333	
	50	Iodinated contrast media are used for tagging and also may have a laxative effect.	5.00	.000		5.00	.000	
Faecal tagging	51	Faecal tagging is mandatory.	4.89	.333	**0,378**	5.00	.000	**0,4**
	52	Faecal tagging can be achieved with either iodine or barium or both.	4.78	.667		5.00	.000	
	53	Insufficient scientific evidence exists to favour one tagging agent over the other.	4.33	1.118		4.78	.441	
	54	Iodine results in homogeneous tagging which may facilitates interpretation.	5.00	.000		5.00	.000	
	55	Hyperosmolar iodine based preparations have a laxative effect, which should be taken into account.	5.00	.000		5.00	.000	
	56	Caution is necessary when prescribing iodine-based preparations in cases of known iodine-contrast medium allergy.	5.00	.000		5.00	.000	
	57	Barium is inert and consequently has no cathartic effect but may cause constipation.	5.00	.000		5.00	.000	
	58	Barium may produce heterogeneous tagging of stool and fluid.	5.00	.000		5.00	.000	
	59	Barium suspensions may impair same-day colonoscopy.	5.00	.000		5.00	.000	

Table 2 (continued)

	60	Barium AND iodine combine stool and fluid tagging which may be desirable, but this more complex preparation scheme may reduce patient compliance.	5.00	.000		5.00	.000		
	61	There is a wide variability in patient preparation schemes between experienced centres.	5.00	.000		5.00	.000		
Reading paradigm	62	Interpretation of CT colonography should incorporate both 2D and 3D visualization (i.e. fly-through).	4.89	.333	**N/A**	4.89	.333	**N/A**	
2D and 3D reading	63	Initial interpretation using either primary 2D or primary 3D methods are acceptable depending on personal preference and on WS availability.	5.00	.000		5.00	.000		
	64	On average the primary 2D interpretation is likely to be faster.	5.00	.000		5.00	.000		
	65	Other 3D visualization options (e.g. virtual dissection, panoramic view, filet view, ecc) are viable alternatives provided that the reader is fully trained in conventional 2D and 3D visualisation displays, and is aware that other data display may introduce distortion.	5.00	.000		5.00	.000		
CAD	66	2nd read CAD is recommended because it increases sensitivity for polyp detection without an unacceptable decrease in specificity.	5.00	.000	**1**	5.00	.000	**1**	
	67	Readers should be aware that it is possible to reject true positive CAD prompts in error.	5.00	.000		5.00	.000		
	68	CAD should be adopted by radiologists only after they have been adequately trained in unassisted interpretation of CT colonography and the use of CAD.	5.00	.000		5.00	.000		
	69	CAD is an adjunct to unassisted interpretation and its implementation will depend on local factors including costs, personal preference and algorithm and/or WS availability.	5.00	.000		5.00	.000		
	70	CAD is less likely to be useful in situations were there are multiple false positive prompts, for example a poorly prepared colon.	5.00	.000		5.00	.000		
	71	CAD algorithms have been developed primarily for polyp detection although they may also detect cancer.	5.00	.000		5.00	.000		
Lesion measurement	72	The maximal diameter of a lesion should be measured on the plane that best demonstrates this dimension, excluding any stalk if present, and its segmental location reported.	5.00	.000	**1**	5.00	.000	**1**	
	73	Diameter may be estimated using 2D and or 3D methods but readers should be aware that 3D estimates may occasionally be unreliable.	5.00	.000		5.00	.000		
	74	Readers should be aware that there is frequent disagreement between CT and the endoscopic measurements, and this may influence management when patients are defined by polyp size categories.	5.00	.000		5.00	.000		
	75	Readers should be aware that neither endoscopic nor CT estimates are wholly accurate and both are affected by the way the measurement is made (e.g. CT window level and width). Narrow windows should be avoided.	5.00	.000		5.00	.000		
Flat lesions	76	The precise definition of a flat lesion is variable and controversial at the present time. Lesion height above the surrounding mucosa should be reported when flat lesions are encountered. An increasingly acceptable definition of a flat lesion on CT colonography is one were the elevation of a lesion of 6mm or larger above the surrounding mucosa is 3 mm or less.	4.89	.333	**N/A**	5.00	.000	**1**	
	77	Readers should be aware that CT colonography is less sensitive for flat lesions than for other polyp morphologies.	5.00	.000		5.00	.000		
	78	The likelihood of cancer increases in line with lesion diameter. There is no exclusive threshold that defines cancer at CT colonography. When the morphology of the lesion strongly suggests a cancer this terminology should be used and alternatives such as “mass” should be avoided.	5.00	.000		5.00	.000		
	79	Occasionally factors other than the maximal diameter of a single lesion may be useful to indicate the clinical importance, for example fat attenuation which indicates a lipoma.	5.00	.000		5.00	.000		
Reporting	80	A report should include the Clinical information (under pinning the request should be included in the report, along with personal and family history), the Technical data (low or normal dose protocol, intravenous contrast) and, if desired, preparation and tagging (laxative agent), tagging (tagging regimen), insufflation (air or CO2), spasmolytics (used or not used), the effective dose in mSv.	4.44	1.014	**0,4**	4.44	1.014	**0.4**	
	81	The reported colonic findings should be: colonic anatomy (normal or abnormal.), polyps and cancer (size, shape, maximum diameter, infiltration of the extracolonic fat, location and other colonic (e.g. wall thickening, strictures, diverticula, extrinsic compressions, post-surgical variations).	5.00	.000		5.00	.000		
	82	The extracolonic organs should be interrogated and abnormalities reported, noting the limitations if an unenhanced and or low dose technique was used.	4.89	.333		4.89	.333		
	83	CT colonography should be reported by a radiologist, specifically trained in the technique.	5.00	.000		5.00	.000		

Table 2 (continued)

84	CT Colonography reading requires specific training and expertise in abdominal cross-sectional imaging, which is only conveyed by radiological training	5.00	.000	5.00	.000
85	CT colonography has limited diagnostic value for lesions less than 6 mm. However, if detected with high confidence such lesions might be reported (particularly if ≥3), in both asymptomatic and symptomatic patients.	5.00	.000	5.00	.000
86	All polyps of 6mm or larger should be reported in both asymptomatic and symptomatic.	5.00	.000	5.00	.000

Cronbach's α reliability coefficient normally ranges between 0 and 1. The closer the Cronbach's α coefficient is to 1.0, the greater the internal consistency of the item. An α coefficient>0.9 was considered excellent, α>0.8 good, α>0.7 acceptable, α>0.6 questionable, α>0.5 poor and α<0.5 unacceptable. For the iterations, an α of 0.8 was considered a reasonable goal for internal reliability. All panellist ratings for each statement were also analysed with descriptive statistics, estimating the mean, maximum and minimum score, and their standard deviation.

A mean score of 4 was considered to represent "good" agreement between panellists, a score of 5 "complete" agreement.

Results

Based on the questionnaire provided by the facilitator, the panel elaborated 86 statements that were collected by the facilitator and organised into nine groups, as follows: (1) rectal tube, (2) spasmolytics, (3) colon distension, (4) image acquisition, (5) patient preparation, (6) faecal tagging, (7) reading paradigm, (8) lesion measurement and (9) reporting (Table 2).

In the third round the panelists achieved complete consensus (i.e. mean score 5) in 64 of 86 statements (75 %), which improved to 71 (82 %) in the fourth round (Table 2).

Categories including the highest proportion of statements achieving excellent internal reliability (i.e. Cronbach's α value >0.7) in the final round were colon distension, scan parameters, use of intravenous contrast medium, general guidelines on patient preparation, role of CAD and lesion measurement.

Lower internal reliability was achieved for statements regarding the use of a rectal tube, spasmolytics, decubitus positioning and number of CT data acquisitions, faecal tagging, 2D vs. 3D reading and reporting. However, in the last round, no panellist scored their individual statements as less than 4 on the 5-point rating scale. This indicates that all panellists agreed on the statement but the level of support differed (i.e. "agree somewhat" versus "agree strongly").

Discussion

Full consensus was reached by our expert panel in 82 % of the statements. In the remaining statements, full consensus was not reached but all panellists achieved a "good" level of agreement. In total, the panellists completed fours rounds; the first and second rounds served to elaborate the basic statements. The third and fourth rounds contained the core of the discussion and were necessary to reach the maximum consensus possible, so creating an optimised, homogeneous opinion for each statement.

All panellists exhibited a high level of agreement for the technical performance of CTC, with clear recommendations regarding colon distension, CT parameters, use of intravenous contrast agents and patient preparation. Full agreement was also reached regarding the role of CAD and lesion measurement. These data reflect a general homogeneity of approach between panel members despite their wide geographical spread. All panel members are regular tutors on the ESGAR CTC course, which may have increased their level of agreement; there is a tendency to promote a common message during panel discussions occurring during the ESGAR CTC courses [15, 16]. Furthermore, in these areas the indexed literature is relatively mature and stable; for example available data supporting the use of automated CO^2 for optimal colonic distension is relatively consistent [17–20].

However, certain aspects of practice achieved less than "full" agreement. In particular, a digital rectal examination, before insertion of the rectal tube (if rectal examination had not been performed previously), was not standard practice in many centres, but was nevertheless recommended by some panellists (with a mean score 4.56). This difference could be explained by the practice to perform a digital rectal examination before CTC amongst a few of the experts involved in the consensus. Similarly, practice differed regarding the use of intravenous spasmolytics, with many administering such agents to all patients, whereas some (in Italy) only used it in selected individuals [21, 22]. Accordingly, use of spasmolytics is recommended by the majority but is not considered mandatory.

There were minor variations in recommended CT parameters between panellists but all recommended data acquistion in at least two patient positions, without any overall preference regarding the order of acquisitions (i.e. supine or prone first). The differences in CT protocols included the need for additional CT data acquisition and insufflation in cases of poor colonic distension; a minority of experts did not consider this mandatory although they agreed it should be recommended. An additional decubitus acquisition was recommended, if required, to improve the diagnostic quality of the examination [23, 24].

Although available CT technology differed among panellists, all agreed that 2.5-mm collimation was the maximum permissible (although thinner collimation is recommended when available) and use of low radiation dose protocols is to be employed when the overriding purpose of the study is the evaluation of the colonic lumen, for example as in screening [25, 26]. A low radiation dose should be considered a study in which the median effective dose is lower than 5.7 mSv, according to the results of the survey by Leidenbaum et al. [26]. For the staging of patients with known malignancy all the panellists agreed upon the use of standard-dose protocols and intravenous contrast medium [27, 28].

Substantial agreement was reached between panelists regarding the reading methods for interpretation of CT colonography. A combination of 2D and 3D reading was emphasised. Most of the panel were primary 2D readers but all recognised the importance of 3D integration, noting the range of different three-dimensional approaches available. The need for the reader to be adequately trained before interpreting CT colonography was emphasised and is strongly supported by the indexed literature [29–33].

Computer-aided diagnosis was acknowledged by all panellists as a potentially useful tool for CTC interpretation, if employed in a second reader paradigm. Accordingly, the use of CAD was recommended provided that readers have already undergone adequate training in general CT colonography interpretation so that they can discriminate between true- and false-positive CAD marks appropriately [34–42].

Panellists acknowledged that accurate polyp measurement is problematic for both CTC and endoscopy, with some evidence that CTC may be the superior technique [43, 44]. Despite this advantage, it is still uncertain whether a 2D or a 3D measurement should be made from CT. Moreover, the accuracy of such measurements has important clinical implications for the correct classification and risk stratification of lesions, influencing subsequent recommendations for patient management [45–50]. The panel concluded that the maximal diameter of lesions should be primarily estimated using axial and MPR 2D views (which were considered to be the most reliable), avoiding a narrow CT window. Some caution should be exercised when measurements are taken using 3D perspectives given the potential for distortion generated by the three-dimensional endoluminal rendering [51–55].

All panellists agreed that CTC should only be reported by a radiologist, and then only after adequate training [56–59]. Motivations behind this recommendation are mainly the medico-legal implications of non-radiologists reporting CTC in EU countries. In all EU countries the radiological report is definitively validated by the radiologist despite, in a few centres, a preliminary reading being performed by a radiographer. Adequate training means having interpreted a minimum amount of colonoscopy-verified cases. Although the precise number has not yet been clearly defined, the literature shows that 175 is even not sufficient for several individuals [60, 61].

It was acknowledged that diagnostic accuracy is lower for polyps with a maximal diameter less than 6 mm [3, 4] but if detected with high confidence, and particularly if more than three in number, such polyps should still be reported. This contrasts with recommendations from the CT Colonography Reporting and Data System (C-RADS), authored by Zalis et al., where lesions less than 6 mm are considered diminutive and the recommendation is that they should not be reported [45]. The panel agreed that the patient's risk (age, family history of colorectal cancer, previous polypectomy, etc.), as well as the number of diminutive lesions detected, should be considered in the decision to report them or not.

There was little disagreement between panellists regarding the need to calibrate the laxative effect of bowel preparation/purgation to the individual patient and potential target lesion. All panellists agreed that faecal tagging should be used routinely. Different preferences for specific laxative and tagging agents were expressed (for example sodium phosphate, magnesium citrate, polyethylene glycol for cleansing, and barium, iodine or a combination of both agents for tagging), reflecting local practice [62–75].

In summary, the panel covered all important aspects regarding the practice of CTC and reached full agreement on most statements. The Consensus has been structured to give clear guidelines for the practice of CT colonography. The recommendations should be useful for both the radiologist who is starting a CTC service and for those who have already implemented the technique but whose practice may need updating in the light of recent developments.

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