RESEARCH ARTICLE

Inter observer reliability for peritoneal carcinomatosis at computed tomography

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Abstract

Objective: To determine whether there is inter-observer reliability between radiologists for reporting peritoneal carcinomatosis and computed tomography peritoneal carcinomatosis index estimation.

Method: The retrospective, cross-sectional study was conducted at Dow Institute of Radiology, Dow University of Health Sciences (DUHS), Ojha campus and comprised computed tomography scans done between December 1, 2019, to May 31, 2020, that were extracted from the institutional database searched using key words 'peritoneal carcinomatosis' and/or 'serosal deposits'. The first readers had 1-4 years of post-fellowship experience, while the 2nd readers were senior radiologists. Inter-observer reliability was assessed quantitatively and qualitatively for 15 peritoneal sites using, among other tolls, the Sugarbaker computed tomography peritoneal carcinomatosis index. Data was analysed using SPSS 21.

Results: Out of 236 subjects with mean age 53.6±13.6 years, there were 173(73.3%) females and 63(26.7%) males. The most common primary cancer was ovarian 145(61.4%), followed by colon 26(11%). The size of peritoneal deposit was not reported in 75(31.8%) cases. Of the 15 sites analysed, good agreement was not found in 7(46.7%). There was an excellent intra-class correlation for measuring computed tomography peritoneal carcinomatosis index scores among the radiologists irrespective of the grade of the faculty (>0.90).

Conclusion: The inter-observer reliability was low, but good agreement for computed tomography peritoneal carcinomatosis index would encourage radiologists to use it in peritoneal cancer reporting.

Key Words: Computed tomography, Inter-observer reliability, Peritoneal carcinomatosis, Reporting, Agreement.

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Introduction

The peritoneum is a complex organ with multiple sub-sites, peritoneal ligaments and infoldings. Peritoneal carcinomatosis (PC) occurs secondary to dissemination of gynaecological and non-gynaecological neoplasm, including ovarian, endometrial, gastric oesophageal, colorectal, appendiceal, gallbladder and pancreatic malignancies. Computed tomography (CT), magnetic resonance imagining (MRI) and 18F fluorodeoxyglucose positron emission tomography (18F-FDG-PET) scans are non-invasive tools for peritoneal malignancy[1].

CT is a first-line investigation for the diagnosis and surveillance of PC because of its cost-effectiveness and widespread availability compared to the other modalities. Accurate estimation of PC can have a profound impact on the management of ovarian cancer patients. It can change the management plan from R0 to R1 resection. Deposits >2cm, implants at the diaphragm, lesser sac, porta hepatis, inter-segmental fissure, gallbladder fossa, or gastro-splenic or gastro-hepatic ligament also represent non-resectable disease[2]. Akin O et al.[3] studied CT for differentiating peri-hepatic metastases with and without liver parenchymal invasion (LPI) in patients with ovarian cancer via radiologists with different experience levels. They concluded that CT had sensitivity up to 100% and 80% for detecting peri-hepatic metastases with and without LPI respectively.

CT scanning creates a road map and surgical global positioning system (GPS) for PC. In terms of experience, clinicians' feedback and literature search, smaller lesions are missed on CT[4]. It is a well-established phenomenon that double reading in diagnostic radiology can find discrepancies in the radiologists' report, but it is time- and resource-consuming.

The current study was planned to determine inter-observer reliability (IOR) between radiologists for reporting PCs and CT PC index (CT-PCI) estimation. The null hypothesis was that IOR would be high.

Materials and Methods

The retrospective, cross-sectional study was conducted at Dow Institute of Radiology, Dow University of Health

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Sciences (DUHS), Ojha campus and comprised CT scans done between December 1, 2019, to May 31, 2020. After ethical approval from Institutional review board (IRB) of DUHS (Ref No. IRB/1771/ DUHS/Approval/2020), data was extracted from the institutional database using non-probability purposive sampling technique and searched using key words 'peritoneal carcinomatosis' and/or 'serosal deposits'. The contrast-enhanced abdominal CT scans had been performed using 16-slice (Hitachi and Siemens) and 128-slice (GE Healthcare) scanners. The chosen slice thickness was 1mm (thin), reconstruction interval 0.5mm, volumetric acquisition, detector collimation 10mm, slice thickness pitch 1.75, number of detector channels 57 (16 rows), and the width of each detector channel 2mm.

All relevant CT reports of 15 sites were extracted. Images were acquired via thin-section (1.6mm) CT with overlapping section protocol with 16-slice and 64-slice scanners. Cases with incomplete information were excluded, and so were CT scans related to sites other than the 15 sites selected for the current study. Reporting had been done by Reader I individually, who was an academic radiologist working as Instructor, Senior Instructor or Assistant Professor with a different level of post-fellowship experience. The faculty was assigned a grade according to length of experience: Grade 1 = up to 2 years, Grade 2 = 2-5 years, Grade 3 = >4 years.

The retrospective analysis of all the scans was done by Reader II, an experienced consultant radiologist with pertinent background knowledge. The same CT scans were reviewed on digital imaging communication in medicine (DICOM) viewer with multi-planar reconstructions (MPRs) with appropriate windowing. All peritoneal sites were explored and hidden areas of the peritoneum at CT, including liver hilum, sub-phrenic area and the root of the mesentery were scrutinised (Figure-A). Reports were searched if size of the largest reachable peritoneal deposit for intervention was mentioned. The extent of lymphadenopathy was re-assessed. Difference in PC terminology compared with international lexicon was noted. CT-PCI was calculated according to the number of peritoneal sites by two readers based on Sugarbaker´s CT-PCI score[5], which is defined as the sum of sizes of the lesions in 13 abdomino-pelvic regions in clockwise direction (Figure B): S0 = no tumour visible; S1 = lesion size <0.5cm; S2 = lesion size 0.5-5cm, and S3 = lesion size >5cm. To avoid reporting bias, findings of both readers were recorded by separate data collectors, and data was kept anonymous.

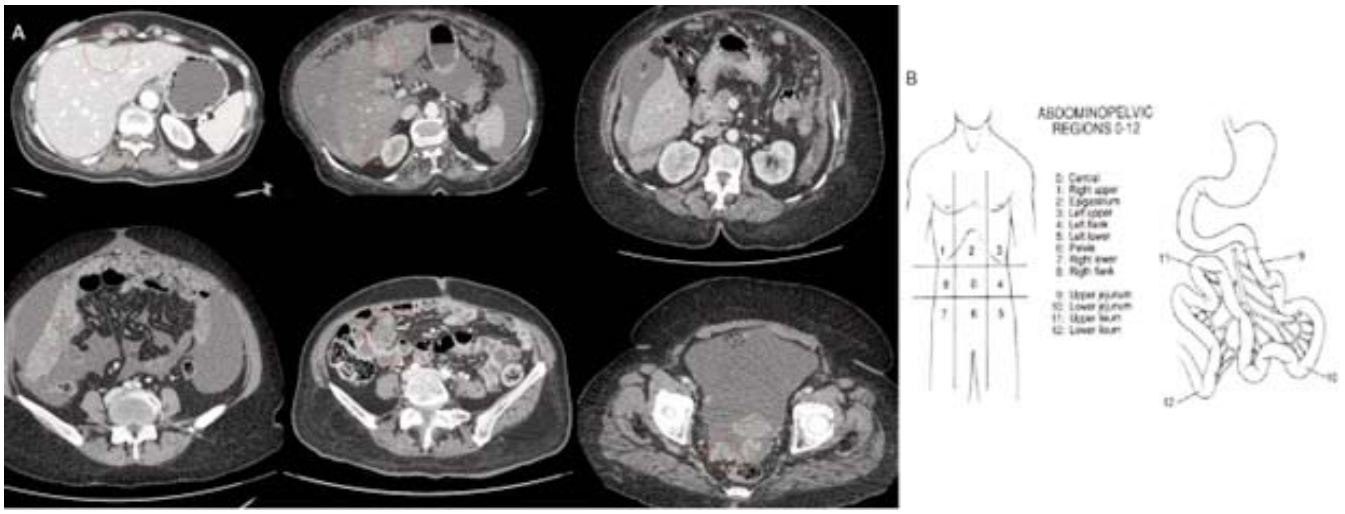

Figure: (A) Axial contrast computed tomograpgy (CT) sections of the abdomen showing subcapsular, intrahepatic fissure, Morison's pouch, omental, mesenteric, cul-de-sac deposits. (B) Measurement method of Peritoneal Carcinomatous index (PCI) estimation.

Data was analysed using SPSS 21 and R software 4.0.3. For qualitative outcome (cancer sites), statistical agreement was checked between Readers I and II using observed agreement and AC1Gwetz statistic. For quantitative outcome (PCI score), intra-class correlation (ICC) was computed between the radiologists. IOR was categorised on the basis of ICC estimate with 95% confident interval (CI); <0.5 = poor, 0.5-0.75 = moderate, 0.75-0.9 = good, >0.9 = excellent. P<0.05 was considered statistically significant.

Results

Out of the 236 subjects with mean age 53.6±13.6 years, there were 173(73.3%) females and 63(26.7%) males. The most common primary cancer was ovarian 145(61.4%), followed by colon 26 (11%). The size of peritoneal deposit was not reported in 75(31.8%) cases. Supra-diaphragmatic lymphadenopathy was seen in 100(42.4%) cases, and was missed to be mentioned in 83(83%) of such cases. Among the first Readers, 23(9.7%) were instructors, 154(65.3%) were senior instructors and 58(24.6) were assistant professors (Table 1).

Table-1: Descriptive data.

Characteristics	N = 236 (%)
Age (years) (Mean ± SD)	53.6 ± 13.6
Gender	
Female	173 (73.3)
Male	63 (26.7)
Primary Cancer	
Ovarian	145 (61.4)
Colon	26 (11.0)
Gall Bladder	19 (8.1)
Gastric	18 (7.6)
HCC	07 (3.0)
Endometrial	05 (2.1)
Others	19 (8.1)
Missed Relevant findings	
Size of peritoneal deposit	75 (31.8)
Designation (Experience)	
Instructor (1 year)	23 (9.7)
Senior Instructor (> 2 years)	154 (65.3)
Assistant Professor (> 4 years)	58 (24.6)

SD: Standard deviation, HCC: Hepatocellular carcinoma.

The 'Others' category included cholangiocarcinoma (4 cases), breast (3), pancreatic (2), and oesophageal, fallopian, peri-ampullary, retroperitoneal, sarcoma, sigmoid and uterine (1 each).

Of the 15 sites analysed, good agreement was not found in 7(46.7%). Senior instructors and assistant professors had a good agreement with the second reader, with agreement >70% and AC1Gwetz estimate >0.60 on 5(33.3%) sites; subphrenic space, intrahepatic fissure, porta-hepatis, splenic hilum, and lesser sac. On 2(13.3%) sites, fine peritoneal nodularity and subcapsular implant, a good agreement of the second reader with instructor was observed with agreement >70% and AC1Gwetz estimate >0.60 (Table 2).

Table-3: Total Sugarbaker´s PCI score mean (interquartile range) and agreement among the groups of academic radiologists

CTSI Score	Instructor	Senior Instructor	Assistant Professor	Overall
Reader I	32 (29)	8 (28)	8 (28)	8 (28)
Reader II	34 (36)	12 (28)	12 (28)	12 (30)
p-value¥ (Reader I vs II)	< 0.001	< 0.001	< 0.001	< 0.001
ICC (P-value)	0.93 (<0.001)	0.96 (<0.001)	0.95 (<0.001)	0.95 (<0.001)

¥Wilcoxon Signed Rank Test. PCI: Peritoneal carcinomatosis index, ICC: Intra-class correlation.

There was an excellent ICC for measuring CT-PCI scores among the radiologists irrespective of the faculty grade (>0.90) (Table 3).

Table-2: Cancer site inter-observer agreement among different groups of academic radiologists.

Peritoneal Site*	Instructor		Senior Instructor		Assistant Professor		Overall	
	OA	Est	OA	Est	OA	Est	OA	Est
Fine peritoneal nodularity	74%	0.63	70%	0.53	67%	0.47	69%	0.51
Subphrenic space	70%	0.56	79%	0.72	75%	0.64	75%	0.66
Intrahepatic fissure	65%	0.51	73%	0.62	75%	0.68	74%	0.65
Porta hepatis	70%	0.56	79%	0.73	77%	0.7	77%	0.7
Sub-capsular implant	78%	0.68	75%	0.57	74%	0.59	75%	0.59
Splenic hilum	70%	0.56	79%	0.74	81%	0.75	79%	0.73
Lesser sac	100%	0.47	84%	0.8	77%	0.69	78%	0.71
Omentum	48%	-0.03	46%	-0.07	57%	0.19	53%	0.09
Morrison's pouch	57%	0.34	54%	0.23	64%	0.43	60%	0.37
Serosal	65%	0.4	69%	0.43	68%	0.41	68%	0.41
Mesentery	57%	0.25	61%	0.32	64%	0.38	62%	0.35
Para-colic gutter	65%	0.36	67%	0.52	62%	0.4	64%	0.43
Cul-de-sac	57%	0.17	64%	0.44	64%	0.4	63%	0.39
Adnexa	65%	0.36	73%	0.56	71%	0.53	71%	0.52
Umbilical	48%	0.15	58%	0.36	63%	0.44	60%	0.39

OA: Observed agreement, Est: Estimated.

Discussion

Over the last decade, CT-PCI has emerged as an excellent tool for accurate PC estimation as it combines the distribution of peritoneal tumour with tumour size with results near analogous to laparotomy and laparoscopy[5]. Jónsdóttir B et al.[6] found a cut-off value of CT-PCI >24 to achieve complete Cyto-reductive surgery (CRS). In the current study, mean CT severity index (CTSI) score ranged 28-30, with excellent reliability.

The prognostic significance of CT–PCI was evident from poster of Cecilia R et al. They also divided cavity into 13 regions and estimated maximum score up to 39 PCI of >20 as a relative contra-indication to intervention[7]. Low RN et al. in 2015[8] studied accuracy of pre-operative CT and MRI in 22 patients retrospectively, who had undergone surgery, and concluded that CT had a bit lower sensitivity, (55%), specificity (86%) and accuracy (63%) than MRI; 95%, 70% and 88%, respectively.

Reporting by radiologists can have discrepancies that are inevitable[9,10]. Geijer H. et al. in 2018 conducted a meta-analysis of 1,610 articles; 46 were then selected for analysis. They found that the discrepancy rate (DR) hovers around 22%, and concluded that double reading by a sub-specialist can lead to high rates of changed reports [11]. Lauritzen P.M. et al.[6] found a discrepancy rate of 14% during double reading of 1,071 consecutive abdominal CT examinations of surgical patients, retrospectively comparing the preliminary and final reports. De Bree E et al reviewed preoperative CT scans from 25 consecutive patients with PC from colorectal or appendiceal origin. The review was done by 2 blinded radiologists independently. They found a significant inter-observer differences[7]. Alternatively, studies[12,13] reported high agreement between radiologists when they reviewed the scans for multiple measurements on abdominal CT scans.

Sagrario LG et al. retrospectively evaluated 48 patients with ovarian carcinoma for PCI estimation, correlated findings with histopathology, and concluded that CT modality and PCI index were useful tools for treatment planning and prognosis[14]. A total of 49 cross-sectional cases were read by experienced and inexperienced radiologists for PCI assessment in a recent international study[15]. Experienced radiologist was better in assessing both modalities) with higher agreement compared to inexperienced radiologist who was better at CT than MRI. In the current study, there was no significant variation in qualitative and quantitative IOR with experience and grade of faculty. For 8 PC sites, including omentum, Morrison's pouch, serosal, mesentery, para-colic gutter, cul-de-sac, adnexa, umbilical', poor IOR was seen (53%; 0.09).

Discrepancy and error is a truth and documented phenomena in Radiology[16,17]. In this study, the size of peritoneal deposit and thickness of omentum had been taken into account if it was mentioned in reports for intervention. Enlarged cardiophrenic lymph nodes (LNs) aka supra-diaphragmatic nodes, predict worsening of survival in ovarian carcinoma patients[18]. In the current study, it was missed to be reported in 83 of the 100 cases. Significant differences in usage of PC terminology have been found. Omental deposits as 'beneath the anterior abdominal wall', Morrison's pouch and sub-capsular as 'peri-hepatic', para-colic gutter as 'peri-colic', cul-de-sac and adnexa as 'pelvic' were the most frequently mis-reported terminology used in the study. Fultz PJ.[19] documented that diagnostic aids, such as checklists and paired simultaneous readings, did not lead to an improved mean observer performance. This PC terminology flaw, detected on 1st reading is due to reasons including lack of appropriate feedback system, surgeon-radiologist communication gap, and lack of discrepancy meetings at the study site.

The study of CT-PCI and PC-IOR agreement were the strength of the current study, as, to the best of the authors' knowledge, the matter has not been studied, and the index is neither very common among radiologists, nor is it practised in the country. It was an audit research to look into error rate of the department in this specific domain.

The current also has a few limitations. The CT findings were not compared with other imaging modalities, and patients were not followed up for the confirmation of per-operative findings. Esquivel et al.[20] found that in 33% of subjects, pre-op CT-PCI score underestimated the extent of carcinomatosis. CT has poor sensitivity in determining small peritoneal tumours. On the other hand, MRI was not chosen for the study because of limited availability, bowel movement artifacts, claustrophobia and financial constraints. A checklist[21] has been recently introduced for accurate reporting of PC at CT[21], but was not applied in the current study.

Conclusion

The IOR was low, but there was good agreement for CT-PCI which would encourage radiologists to use it in PC reporting.

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