Development of deep learning-based auto-segmentation algorithms to diagnose and indicate peritoneal carcinomatosis lesions of ovarian cancer

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Background

- Ovarian cancer is a global burden as it accounts for 314,000 new cases and 207,000 cancer deaths among women every year.
- In patients with epithelial ovarian cancer, peritoneal carcinomatosis (PC) is frequently observed at the time of cytoreductive surgery (CRS) and associated with poor survival outcomes.
- To date, there are only two methods to assess PC before the initiation of primary treatment:
  ① Laparoscopic assessment with Fagotti and peritoneal cancer index (PCI) scoring systems
  ② Imaging-based assessment, such as computed tomography (CT) scans.
- Quantification of PC lesions on pre-treatment CT scan is essential in managing advanced EOC. Nevertheless, manual labelling and quantifying the whole PC lesions on CT scan images requires considerable reader experience in CT interpretation and substantial time and human resources.

Objective

- To develop a deep learning-based auto-segmentation algorithm to identify and indicate PC lesions using CT scan images of EOC patients.

Methods

- We retrospectively collected pre-treatment CT scan images from patients with EOC who were treated at Seoul National University Hospital.
- Patients were randomly assigned to training, development, and test sets with 8:1:1 ratio.
- The tumors and PC lesions in the abdominal-pelvic cavity of the training dataset were manually drawn by one radiologist. Surgical records and descriptions of PC lesions were also referred.
- 3D nnU-Net was selected as the deep-learning architecture.
- One radiologist manually drew lesions of interest in the test dataset twice and submitted them as references for validation.

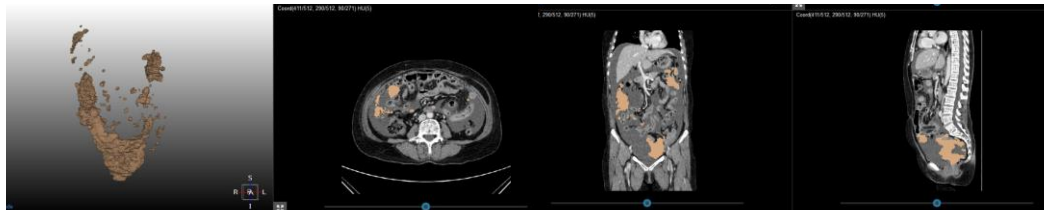
Results

- The whole dataset which consists of 200 patients underwent 5-fold cross validation.
- The final model was validated using corresponding test dataset, and yielded the average Dice similarity coefficient (DSC), sensitivity, and precision as 83.09%, 83.12%, and 83.91% across all folds.

Table 1. Patients' characteristics

Characteristics	All (n=200, %)	Characteristics	All (n=200, %)
Age, years		Ascites	174 (87.0)
Mean ± SD	58.2 ± 11.2	Peritoneal carcinomatosis	188 (94.0)
BMI, kg/m²		Primary treatment strategy	
Mean ± SD	23.5 ±3.2	PDS	140 (70.0)
Serum CA-125, IU/mL		NAC-IDS	60 (30.0)
Median	894.0	Residual tumor after surgery	
FIGO stage		No gross	115 (57.5)
IC–IIIA	9 (4.5)	<1 cm	49 (24.5)
IIIB–IIIC	123 (61.5)	≥1 cm	36 (18.0)
IV	68 (34.0)	Chemotherapy regimen	
Histologic subtype		Paclitaxel-Carboplatin	179 (89.5)
High-grade serous	155 (77.5)	Docetaxel-Carboplatin	14 (7.0)
Low-grade serous	4 (2.0)	Paclitaxel-Carboplatin-BEV	7 (3.5)
Endometrioid	16 (8.0)	Total cycles of chemotherapy	
Mucinous	8 (4.0)	4–6	137 (68.5)
Clear cell	7 (3.5)	7–9	54 (27.0)
Others	10 (5.0)	10–12	9 (4.5)

Figure 1. Application of deep learning-based auto-segmentation algorithm



Conclusions

- We successfully developed a deep learning-based auto-segmentation algorithm to identify and indicate PM lesions in ovarian cancer.
- This model will aid radiologists' reading and facilitate image-guided surgery for advanced-stage ovarian cancer in clinical practice.

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