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Clinical Investigation: Gynecologic Cancer

Anatomic Distribution of Fluorodeoxyglucose-Avid Para-aortic Lymph Nodes in Patients With Cervical Cancer

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Summary

This study presents a map of positron emission tomography (PET)-positive para-aortic nodes (PAN) in cervical cancer. Available information about the location of PAN metastases in cervical cancer is not adequately detailed to guide treatment planning for highly conformal radiation therapy. Our population-based atlas outlines the spatial distribution of these lymph nodes to facilitate target delineation and treatment planning. Suggested clinical target volume contours are included, which provide coverage of PAN nodes for

Purpose: Conformal treatment of para-aortic lymph nodes (PAN) in cervical cancer allows dose escalation and reduces normal tissue toxicity. Currently, data documenting the precise location of involved PAN are lacking. We define the spatial distribution of this high-risk nodal volume by analyzing fluorodeoxyglucose (FDG)-avid lymph nodes (LNs) on positron emission tomography/computed tomography (PET/CT) scans in patients with cervical cancer.

Methods and Materials: We identified 72 PANs on pretreatment PET/CT of 30 patients with newly diagnosed stage IB-IVA cervical cancer treated with definitive chemoradiation. LNs were classified as left-lateral para-aortic (LPA), aortocaval (AC), or right paracaval (RPC). Distances from the LN center to the closest vessel and adjacent vertebral body were calculated. Using deformable image registration, nodes were mapped to a template computed tomogram to provide a visual impression of nodal frequencies and anatomic distribution.

Results: We identified 72 PET-positive para-aortic lymph nodes (37 LPA, 32 AC, 3 RPC). All RPC lymph nodes were in the inferior third of the para-aortic region. The mean distance from aorta for all lymph nodes was 8.3 mm (range, 3-17 mm), and from the inferior vena cava was 5.6 mm (range, 2-10 mm). Of the 72 lymph nodes, 60% were in the inferior third, 36% were in the middle third, and 4% were in the upper third of the para-aortic region. In all, 29 of 30 patients also had FDG-avid pelvic lymph nodes.

Conclusions: A total of 96% of PET positive nodes were adjacent to the aorta; PET positive nodes to the right of the IVC were rare and were all located distally, within 3 cm of the aortic bifurcation. Our findings suggest that circumferential margins around the vessels do not accurately define the nodal region at risk. Instead, the anatomical extent of the nodal basin should be contoured on each axial image to provide optimal coverage of the para-aortic nodal compartment.

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Conflict of interest: Dr Lei Dong and Yongbin Zhang: software licensing of deformable image registration to Varian Medical Systems.

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the treatment of cervical cancer.

Introduction

Definitive chemoradiation therapy remains the standard of care for locally advanced cervical cancer. Standard pelvic radiation fields include treatment of the external and internal iliac, obturator, and presacral lymph nodal basins. Patients with involved upper common iliac or para-aortic lymph nodes require treatment of the para-aortic nodal region (1). Inclusion of the para-aortic nodes increases acute and late radiation-induced toxicity as compared to pelvic radiation alone (2, 3). Intensity modulated radiation therapy (IMRT) has the potential to reduce normal tissue toxicity and allow for dose escalation necessary for grossly involved lymph nodes. For successful treatment with conformal radiation, precise delineation of the lymph node region at risk is critical. Currently available information on the location of para-aortic lymph nodes at risk is based on the anatomical distribution of normal lymphatics as well as the distribution of metastatic disease based on surgical and pathologic studies (4-6). However, surgical studies lack the precise anatomic distribution of information that is required for target volume delineation, and grossly involved lymph nodes may not be equally distributed over the region of normal lymphatics.

To address the limitation of the current studies, we have previously investigated the distribution of 2-deoxy-2-[^{18}F] fluorodeoxyglucose positron emission tomography (FDG-PET) positive pelvic lymph nodes in patients with cervical cancer (7). FDG-PET has been shown repeatedly to be highly sensitive and specific in detecting metastatic lymphadenopathy in cervical cancer (8-15). In this study, we analyze para-aortic lymph nodes that were FDG-avid on PET/computed tomography (PET/CT), to outline the spatial and probabilistic distributions of positive para-aortic lymph nodes, providing data for an evidence-based approach to para-aortic radiation therapy field design, particularly to guide conformal therapy.

Methods and Materials

Patients

We retrospectively reviewed the records of patients treated with definitive chemoradiation for locally advanced cervical cancer at the University of Texas MD Anderson Cancer Center (MDACC) in the Department of Radiation Oncology Clinic from 2006 to 211. This study was approved by the Institutional Review Board at MDACC. We identified 30 patients with FDG-avid para-aortic lymph nodes (superior to aortic bifurcation) on pretreatment PET/CT scans. Six patients had stage IB, 12 had stage II (IIA-2, IIB-10), 8 had stage IIIB, and 4 had stage IV (IVA-3, IVB-1) disease. Data for these patients were collectively analyzed for this study.

Lymph node characterization, distribution, mapping and contouring

Each patient's PET/CT images were transferred to a Pinnacle treatment planning system (Philips Healthcare, Andover, MA). FDG-avid lymph nodes were contoured onto the individual PET/CT scans by 2 radiation oncologists (H.F., A.K.). Each contour was then verified by a diagnostic radiologist with expertise in the imaging of gynecologic malignancies (Z.R.I.). Positive lymph nodes in our study were included based on the FDG avidity and CT appearance of the node; therefore no standard SUV cut off was used.

The volumetric center of each lymph node was identified and used for subsequent characterization of location. FDG-avid para-

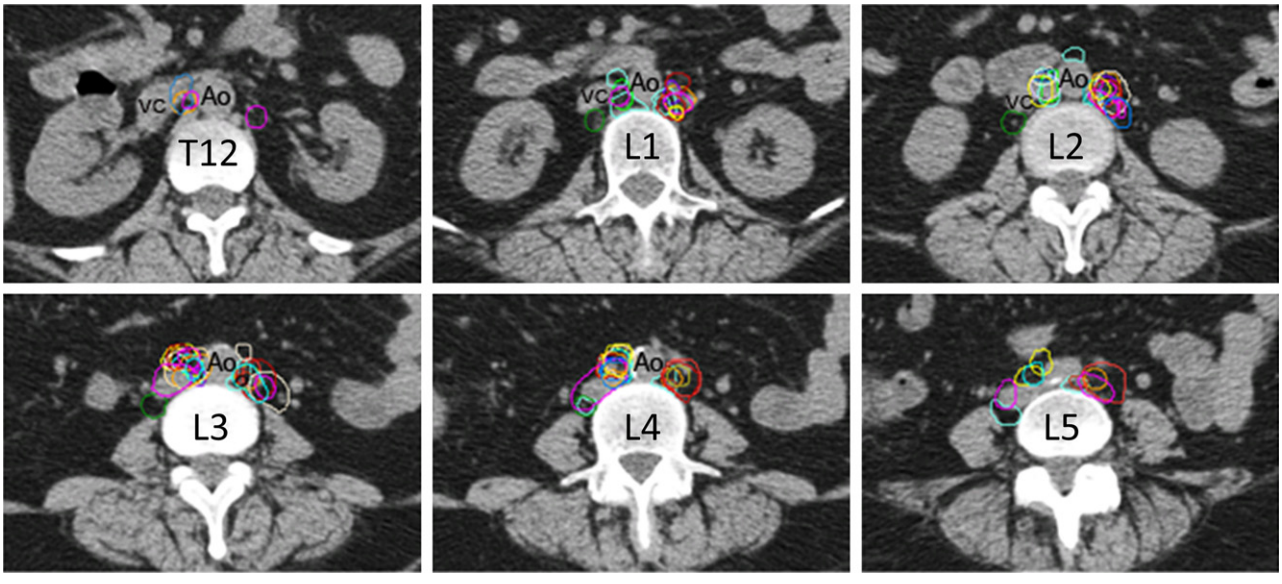

Fig. 1. Axial location of fluorodeoxyglucose (FDG)-avid para-aortic lymph nodes in cervical cancer. Representative axial images (superior to inferior) depicting the location of 72 FDG-avid para-aortic lymph nodes. All lymph nodes from a single patient are contoured in the same color. Ao = aorta; VC = vena cava.