Basic Original Report

Higher Dose to Organs at Risk: The Unintended Consequences of Intravenous Contrast Use in Computed Tomography Simulation for Cervical Cancer

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Abstract

Purpose: To compare the volumes of interest and doses to the organs at risk on contrast and noncontrast scans in patients with cervical cancer who underwent prophylactic extended-field radiation therapy (EFRT).

Methods and Materials: We reviewed twenty cervical cancer patients treated with prophylactic EFRT at Peking Union Medical College Hospital between March 2021 and April 2021. Each patient underwent noncontrast and contrast scans during simulation. All structures were contoured, and radiation therapy plans were created based on both scans. Student t test and Pearson correlation coefficient test were performed.

Results: Compared with the noncontrast scan, on the contrast scan, the mean volume of the inferior vena cava expanded by 44% (P ≤ .001), and the mean volume of the para-aortic nodal clinical target volume increased by 17% (P ≤ .001). For the second portion of the duodenum, the V30 (38.2% vs 43.8%, P = .038), V35 (27.6% vs 35.1%, P = .002), V40 (18.3% vs 26.3%, P = .014), V45 (11.2% vs 18.5%, P = .008), and V50 (4.2% vs 9.1%, P = .005) were significantly lower on the noncontrast scan than on the contrast scan. For the third portion of the duodenum, the V45 (78.4% vs 81.6%, P = .03) and V50 (59.7% vs 67%, P ≤ .001) were significantly lower on the noncontrast scan than on the contrast scan. For the right kidney, the V5, V10, V15, V20, and V25 on the contrast and noncontrast scans were 85.4% versus 79.8% (P = .013), 52.5% versus 45.6% (P = .021), 25.6% versus 20.1% (P = .003), 11.1% versus 7.5% (P = .001), and 3.8% versus 2.3% (P = .027), respectively.

Conclusions: Compared with the noncontrast scan, expansion of the inferior vena cava on the contrast scan can lead to excessive contouring and an overdose to the duodenum and right kidney in cervical cancer patients treated with prophylactic EFRT.

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Research data are stored in an institutional repository and will be shared upon request to the corresponding author.

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1 F.Z. and K.H. contributed equally to this work.
Introduction

Cervical cancer is a major health problem and is the leading cause of cancer-related mortality in women in developing countries. In China, cervical cancer is the sixth most frequently diagnosed cancer and the seventh leading cause of cancer-related mortality in women, with an estimated 109,741 new cases and 59,060 deaths in 2020. Patients with cervical cancer who develop para-aortic lymph node (PALN) metastasis have a poor prognosis. The International Federation of Gynecology and Obstetrics revised the staging system to define PALN metastasis as stage IIIC2 in 2018. Currently, extended-field pelvic and para-aortic radiation therapy is recommended for cervical cancer patients with common iliac or para-aortic lymph node involvement.

For patients with locally advanced cervical cancer, the efficacy of prophylactic extended-field radiation therapy (EFRT) is still controversial. Recent studies have shown that some patients with positive pelvic lymph nodes (PLNs) or stage IIIB disease may benefit from prophylactic EFRT. Similarly, Lee et al reported that patients with positive PLNs or stage III to IVA disease who received prophylactic para-aortic irradiation had reduced para-aortic recurrence and improved cancer-specific survival compared with patients who received pelvic radiation therapy alone. In contrast, some studies suggested that prophylactic EFRT did not lead to a significant improvement in patients with locally advanced cervical cancer without para-aortic lymph node involvement. At Peking Union Medical College Hospital (PUMCH), a phase 3 randomized clinical trial is being conducted to compare the safety and efficacy of pelvic radiation therapy and prophylactic EFRT in patients with high-risk locally advanced cervical cancer (NCT03955367).

Delineation of the para-aortic nodal clinical target volume (CTV) in cervical cancer is worthy of discussion. Keenan et al generated an atlas for accurate para-aortic nodal CTV delineation in cervical cancer patients with para-aortic lymph node involvement. However, a potential limitation to the atlas is that expansion of the inferior vena cava (IVC) on the intravenous (IV) contrast scan may result in excessive contouring and unexpected duodenal and renal toxicities. Furthermore, the Radiation Therapy Oncology Group (RTOG) published an updated consensus of CTV definitions for intensity modulated radiation therapy (IMRT) during postoperative radiation therapy for endometrial and cervical cancers, making a recommendation in 2020 that para-aortic nodal CTV delineation should be based on a noncontrast scan. However, this is an observation based on clinical phenomena and is not supported by specific data. Therefore, the purpose of this study was to compare the volumes of the IVC and the target volume and irradiation dose to the organs at risk (OARs) on IV contrast scans and noncontrast scans in patients with cervical cancer treated with prophylactic EFRT.

Methods and Materials

Patients

Twenty consecutive patients with pathologically proven cervical cancer treated with prophylactic EFRT at PUMCH between March 2021 and April 2021 were reviewed. The median age of the patients was 50 years (range, 26-66 years). Their stages ranged from IIIB to IIIC. Based on recent studies, prophylactic EFRT was performed at PUMCH for cervical cancer patients with common iliac PLNs, pelvic wall involvement, ≥2 PLNs involved or PLNs with a short diameter of ≥1.5 cm. Patients with PALNs demonstrated by imaging or pathology were excluded. This study was approved by PUMCH Ethics Committee (protocol number S-K1641). This study was carried out in accordance with the Declaration of Helsinki. Written informed consent was obtained from all patients before enrollment.

Simulation

Before simulation, the patients prepared by emptying the rectum and filling the bladder. Oral meglumine diatrizoate was used to visualize the bowel, and the vagina was marked. Then, each patient underwent a noncontrast computed tomography (CT) scan and an IV contrast CT scan (abdomen-pelvis, 5 mm slice thickness, 16-slice Philips Brilliance Big Bore) in the head-first supine position using thermoplastic material for immobilization. The IV contrast scan was performed with iodine contrast medium.

IVC measurements

The volume of the IVC was measured from the aortic bifurcation to the level of the left renal vein on the IV contrast scan and on the noncontrast scan. The major axis and the minor axis were measured. IVC expansion was measured in the following directions: (1) the anterior direction: the distance from the anterior boundary of the IVC to the horizontal midline of the vertebral body, defined as D1; (2) the posterior direction: the distance from the posterior boundary of the IVC to the horizontal midline of the vertebral body, defined as D2; (3) the left lateral direction: the distance from the left lateral boundary of the IVC to the vertical midline of the vertebral body, defined as D3; and (4) the right lateral
direction: the distance from the right lateral boundary of the IVC to the vertical midpoint of the vertebral body, defined as D4.

**Delineation**

The CTV for EFRT included the cervix, uterus, vagina, ovaries, parametrium, pelvic, and para-aortic lymph node regions. The OARs included the bladder, rectum, bowel bag, bone marrow, femoral heads, kidneys, liver, spinal cord, second portion of the duodenum (Duo2), and third portions of the duodenum (Duo3). All structures were manually contoured on the IV contrast scan and the noncontrast scan in accordance with the RTOG guidelines. Notably, the contours were slightly adapted from the RTOG guidelines to avoid bias between the noncontrast and IV contrast scans. First, we used uniform expansion from the IVC (3-5 mm anterolaterally) instead of gradual inclusion of the IVC on the IV contrast scan. Second, the duodenum was cropped to create the final CTV. The contours were delineated by radiation oncologist #1 (D.W., 7 years of clinical experience) and reviewed by experienced radiation oncologist #2 (K.H., 26 years of clinical experience). The difference in the position of the IVC with a similar para-aortic nodal CTV on an IV contrast scan (a, b, c) and a noncontrast scan (d, e, f) is shown in Figure 1. The delineation of the upper abdominal OARs on an IV contrast scan (a) and a noncontrast scan (b) is shown in Figure 2. For patients with PLNs, the gross tumor volume of the PLNs was defined as the GTV-N. The planning target volume of the PLNs (PTV-N) was defined as the GTV-N plus margins of 5 mm. The planning target volume (PTV) margins were 7 to 10 mm from the CTV for setup errors and other uncertainties.

**Dose prescription**

All patients were treated with prophylactic extended-field concurrent chemoradiotherapy. Radiation therapy included external beam radiation therapy and high-dose-rate brachytherapy. External beam radiation therapy was delivered with volumetric-modulated arc therapy on a TrueBeam system (version 2.7; Varian Medical Systems, Palo Alto, CA), and the dose prescription (50.4 Gy in 28 fractions; 1.8 Gy/fraction) was delivered to at least 95% of the PTV with a simultaneous integrated boost of 60.2 Gy in 28 fractions (2.15 Gy/fraction) to at least 95% of the PTV-N. In addition, near-minimum absorbed dose (D98%) ≥95% of the prescribed absorbed dose and near-maximum absorbed dose (D2%) ≤107% of the prescribed absorbed dose were recommended. For patients with primary tumor extension to the pelvic wall, the dose schedule of the parametrium was an additional 10 Gy in 5 fractions for a total dose of 60.4 Gy in 33 fractions. The plans were created based on the respective scans by medical physicist #3 (Y.L., 4 years of clinical experience) and reviewed by experienced medical physicist #4 (B.Y., 18 years of clinical experience) and experienced radiation oncologist #2 (K.H., 26 years of clinical experience). High-dose-rate brachytherapy was delivered with an Ir-192 source, with 30 Gy in 5 fractions or 28 Gy in 4 fractions to point A. Weekly cisplatin (40 mg/m²) was used as the first-line regimen of concurrent chemotherapy. The dose constraints of the OARs adapted from the RTOG 1203 guidelines were as follows: bladder, V45

![Figure 1](image-url) Para-aortic nodal CTV on IV contrast scans (a, b, c) versus noncontrast scans (d, e, f). Note the marked difference in the IVC expansion on the contrast scan that leads to excessive contouring. **Abbreviations:** CTV = clinical target volume, IV = intravenous, IVC = inferior vena cava.
≤50%; rectum, V45 ≤50%; bowel bag, V25 ≤50%, D2 cm³ ≤54 Gy; bone marrow, V20 ≤90%; left femoral head, V40 ≤5%; right femoral head, V40 ≤5%; left kidney, V20 ≤30%; right kidney, V20 ≤30%; liver, V10 ≤30%; spinal cord, D0.1 cm³ ≤45 Gy; Duo2, Dmax ≤54 Gy; and Duo3, Dmax ≤54 Gy.19,20

Statistics

All statistical analyses were performed with SPSS version 26 (IBM Corp, Armonk, NY). Quantitative variables are summarized using the mean and standard deviation. Correlations between quantitative variables were assessed using Pearson correlation coefficient. Differences between the volumes of interest and doses to the OARs of the 2 CT scans were compared with Student t test. A 2-sided P value less than .05 was considered significant.

Results

A descriptive summary of the volumetric comparison of the IVC and CTV between the 2 scans is shown in Table 1. The mean volume of the IVC on the IV contrast scan expanded by 44% (18.9 cm³ vs 13.1 cm³, P ≤ .001) compared with that on the noncontrast scan. The major axis and minor axis of the IVC, D1, and D4 on the IV contrast scan were greater than those on the noncontrast scan. An example of the difference in the size of the IVC on an IV contrast scan and a noncontrast scan is illustrated in Figure 3. The expansion of the IVC in the anterior direction (D1) and the right lateral direction (D4) was significant (P ≤ .001), and there was no marked difference in the posterior direction (D2; P = .067) or the left lateral direction (D3; P = .763). The mean distances of the extension of the IVC on the IV contrast scan in the anterior direction (D1) and the right lateral direction (D4) were approximately 3 mm and 2 mm, respectively.
compared with those on the noncontrast scan \((P \leq .001)\). The expansion of the IVC maximally displaced the duodenum anteriorly by nearly 7 mm and made the excessive contouring come closer to the right kidney by nearly 5 mm.

Dilation of the IVC was significantly correlated with enlargement of the para-aortic nodal CTV on the IV contrast scan \((P = .003)\). Moreover, enlargement of the para-aortic nodal CTV was significantly associated with expansion of the PTV on the IV contrast scan \((P = .001)\). The mean volume of the para-aortic nodal CTV on the IV contrast scan increased by 17\% (117.8 cm\(^3\) vs 100.9 cm\(^3\), \(P \leq .001\)) compared with that on the noncontrast scan, mainly manifesting in the anterior direction and the right lateral direction of the IVC. The mean volume of the PTV on the IV contrast scan was approximately 42 cm\(^3\) higher than that on the noncontrast scan \((P \leq .001)\).

The dosimetric comparison between the duodenum and right kidney between the 2 treatment plans is shown in Table 2. There was a significant difference in the high dose level (V30, V35, V40, V45, V50) to Duo2 between the 2 treatment plans. V30 (43.8\% vs 38.2\%, \(P = .038\)), V35 (35.1\% vs 27.6\%, \(P = .022\)), V40 (26.3\% vs 18.3\%, \(P = .014\)), V45 (18.5\% vs 11.2\%, \(P = .008\)), and V50 (9.1\% vs 4.2\%, \(P = .005\)) were significantly lower on the noncontrast scan than on the contrast scan. However, no difference was found in the low dose level (V5, V10, V15, V20, V25) or maximum dose to Duo2 between the 2 treatment plans. Similarly, for Duo3, V45 (81.6\% vs 78.4\%, \(P = .03\)), and V50 (67\% vs 59.7\%, \(P \leq .001\)) were significantly lower on the noncontrast scan than on the contrast scan. Moreover, the maximum dose and the dose to 2 cm\(^3\) (D2 cm\(^3\)) were significantly lower on the noncontrast scan \((P = .017\) and \(P \leq .001\), respectively).
Table 2  Dosimetric comparison between IV contrast and noncontrast scans

<table>
<thead>
<tr>
<th></th>
<th>Duo2</th>
<th>Duo3</th>
<th>Right kidney</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>IV contrast (Mean ± STD)</td>
<td>Noncontrast (Mean ± STD)</td>
<td>P</td>
</tr>
<tr>
<td>V5</td>
<td>81.2 ± 18.6%</td>
<td>80.2 ± 17.1%</td>
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<tr>
<td>V10</td>
<td>70.6 ± 21.8%</td>
<td>69.4 ± 19.8%</td>
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<tr>
<td>V15</td>
<td>63.9 ± 24.3%</td>
<td>62.3 ± 21%</td>
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<td>V20</td>
<td>58.9 ± 25.4%</td>
<td>56.1 ± 21.1%</td>
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</tr>
<tr>
<td>V25</td>
<td>52.4 ± 25.4%</td>
<td>48.4 ± 21.9%</td>
<td>.123</td>
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<tr>
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<tr>
<td>V35</td>
<td>35.1 ± 25.8%</td>
<td>27.6 ± 16.2%</td>
<td>.022</td>
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<tr>
<td>V40</td>
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<td>18.3 ± 11.6%</td>
<td>.014</td>
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<tr>
<td>V45</td>
<td>18.5 ± 16.6%</td>
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<td>.008</td>
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<tr>
<td>V50</td>
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<td>4.2 ± 3.7%</td>
<td>.005</td>
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<tr>
<td>V50</td>
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<td>1.5 ± 1.5 cm³</td>
<td>.002</td>
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<tr>
<td>Dmean</td>
<td>25.46 ± 9.59 Gy</td>
<td>23.34 ± 7.03 Gy</td>
<td>.031</td>
</tr>
<tr>
<td>Dmax</td>
<td>52.24 ± 1.11 Gy</td>
<td>51.82 ± 1.67 Gy</td>
<td>.06</td>
</tr>
<tr>
<td>D2cc</td>
<td>45.89 ± 6.51 Gy</td>
<td>45.34 ± 6.29 Gy</td>
<td>.358</td>
</tr>
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</table>

Abbreviations: Dmean = the mean dose; Dmax = the maximum dose; Duo2 = second portion of the duodenum; Duo3 = third portion of the duodenum; IV = intravenous. P < .05 values are statistically significant.
For the right kidney, the V5, V10, V15, V20, and V25 on the IV contrast scan and the noncontrast scan were 85.4% versus 79.8% ($P = .013$), 52.5% versus 45.6% ($P = .021$), 25.6% versus 20.1% ($P = .003$), 11.1% versus 7.5% ($P = .001$), and 3.8% versus 2.3% ($P = .027$), respectively. Compared with the IV contrast scan, the mean dose to the right kidney ($D_{\text{mean}}$) and the maximum dose to the right kidney ($D_{\text{max}}$) were reduced by 10.7% (11.59 Gy vs 10.35 Gy, $P = .002$) and 16.7% (40.93 Gy vs 34.08 Gy, $P \leq .001$), respectively, on the noncontrast scan. However, there was no significant difference in the high dose levels (V30, V35, V40, V45, V50) to the right kidney between the 2 treatment plans. A comparison of the dose-volume histograms (DVHs) with the 2 treatment plans for one representative patient is shown in Figure 4.

Discussion

Regional lymph node metastasis is one of the important metastatic routes of locally advanced cervical cancer, and it is more common in the pelvic and para-aortic lymph node regions. Generally, in cervical cancer, the para-aortic lymph node region is defined as the area adjacent to the aorta and IVC from the aortic bifurcation to the level of the left renal vein. A review of 22 articles that evaluated the safety and effect of the pretreatment PALN stage on cervical cancer treatment revealed that PALNs were present in 18% (range, 8%-42%) of patients with stage IB to IVA disease.21 The Image guided intensity modulated External beam radiochemotherapy and MRI based adaptive BRTChytherapy in locally advanced CErvical cancer study reported that 52% of patients presented with lymph node involvement based on radiographic findings at diagnosis; of these patients, 14% had involvement in the PALN region.22 Moreover, Ramirez et al suggested that 12% of patients with negative PLNs and PALNs on positron emission tomography/computed tomography had pathologic para-aortic lymphadenopathy, and 22% of patients with positive PLNs but negative PALNs on positron emission tomography/computed tomography had pathologic para-aortic lymphadenopathy.23

Lymph node metastasis, especially PALN metastasis, negatively affects the prognosis of cervical cancer.24 PALN failure may be one of the most common patterns of failure. The Image guided intensity modulated External beam radiochemotherapy and MRI based adaptive BRTChytherapy in locally advanced CErvical cancer study reported that 11% of patients developed nodal failure; of these patients, 68% had PALN failure.22 For patients with cervical cancer with pelvic but not para-aortic lymph node involvement, prophylactic EFRT conferred potential survival benefits.4,5 A multi-institutional observational study among 11 countries in East and Southeast Asia demonstrated that prophylactic extended-field concurrent chemoradiotherapy was feasible and effective for cervical cancer patients with pelvic lymph node metastasis.25 Therefore, our study was based on prophylactic EFRT in high-risk patients with locally advanced cervical cancer.

At present, delineation of the para-aortic nodal CTV is based on the anatomic distribution of PALNs in patients with cervical cancer but this remains controversial. Chao et al recommended that the para-aortic nodal CTV consists of the aorta plus 2 cm, the IVC plus 1 cm, and 5 mm ventral to the aorta to cover 100% of the lymphangiography-avid PALNs.26 Keenan et al proposed that 10 mm circumferentially and 15 mm laterally para-aortic nodal
CTV expansion from the aorta, 8 mm anteromedially and 6 mm posterolaterally from the IVC, provided 97% coverage of the PALNs. However, Kabolizadeh et al and Takiar et al suggested that the majority of PALNs were in the left para-aortic or aortocaval region and that fixed circumferential margins around the vessels did not accurately define para-aortic nodal contouroing. Due to the few lymph nodes on the right side of the IVC, Yang et al refined a new delineation method of the para-aortic region in prophylactic EFRT that omitted the right portion of the IVC region above L3 from the para-aortic CTV to significantly reduce the dose to the duodenum.28

Due to marked expansion of the IVC on an IV contrast scan, which may result in excessive contouring and an overdose to the OARs, in 2020, the RTOG proposed that a noncontrast scan should be performed for para-aortic nodal CTV delineation. However, this observation was based on clinical phenomena and is not supported by specific data. Therefore, we conducted this study by performing volumetric comparisons of target volumes and dosimetric comparisons of OARs to provide any available data.

Our study demonstrated that compared with the noncontrast scan, obvious expansion of the IVC was present on the IV contrast scan. This resulted in excessive contouring and an overdose to the duodenum and right kidney, leading to potential duodenal injury and renal insufficiency. Although the IVC has inherently lower pressures than the aorta, the highly compliant wall of the IVC permits marked volumetric changes in response to changes in the intravascular blood volume. Our study also found that there was significant anisotropic variability in the IVC geometry, with significantly greater expansion in the anterior direction and the right lateral direction on the IV contrast scan. Due to the physical limitations of the vertebral body, posterior expansion of the IVC is significantly obstructed. In addition, the IVC is generally an ovoid shape with the major axis in a left-anterior oblique configuration, corresponding to the obliquity of the ipsilateral vertebral body. Thus, left lateral expansion of the IVC is also significantly obstructed.

Delineation of the para-aortic nodal CTV is based on the position of the vessels and the anatomic distribution of the PALNs in patients with cervical cancer. The RTOG recommended that the para-aortic nodal CTV should extend laterally 1 to 2 cm from the aorta to the medial border of the left psoas muscle and expand within 3 to 5 mm around the IVC. This approach is based on the idea that contouring the para-aortic nodal CTV is closely related to the positions of the aorta and the IVC. Furthermore, our study suggested that compared with the noncontrast scan, the volume increase in the IVC was significantly correlated with excessive contouring of the para-aortic nodal CTV on the IV contrast scan. This phenomenon manifested mainly in the anterior direction and the right lateral direction of the IVC on IV contrast scan, placing it closer to the duodenum and right kidney.

Radiation treatment planning based on the IV contrast scan does not accurately reflect the daily treatment situation and may lead to uncertain duodenal and renal toxicities. Eifel et al reported that expansion of the IVC on the IV contrast scan displaced the duodenum anteriorly by 5 to 10 mm and may result in unexpected duodenal complications.13 Verma et al recommended that the dose limitation to the duodenum should be performed based on the noncontrast scan.29 Similarly, our study also found a phenomenon in which the noncontrast scan reduced the doses to the duodenum and right kidney compared with the IV contrast scan. Although a noncontrast scan is recommended for CTV delineation, an IV contrast scan should be performed to help locate the lymph nodes and vessels. The duodenum and kidneys are dose-limiting structures for radiation therapy for upper abdominal cancers and gynecologic cancers. Kelly et al proposed that a duodenal V55 ≥1 cm³ was associated with grade 2 or higher duodenal toxicity in patients with unresectable pancreatic cancer treated with concurrent chemoradiotherapy.20 Similarly, Verma et al suggested that a duodenal V55 ≥15 cm³ may increase the risk of duodenal toxicity in patients with gynecologic cancers treated with EFRT.29 Likewise, George et al demonstrated that a duodenal V55 ≥1 cm³ and V50 ≥4 cm³ were correlated with grade 2 and greater duodenal toxicity in patients with gastrointestinal cancers or gynecologic cancers with para-aortic lymph nodes treated with radiation therapy.30 Notably, there was a significant difference in the V50 to the duodenum between the 2 treatment plans in our study. In contrast, Poorvu et al reported that IMRT to para-aortic lymph nodes did not correlate with duodenal toxicity in patients with endometrial or cervical cancer.31 Comparably, Xu et al indicated that IMRT to para-aortic lymph nodes did not correlate with high-grade, late duodenal toxicity in patients with endometrial or cervical cancer.32 The incidence of radiation-induced kidney injury is likely underestimated due to its long course and because renal insufficiency is generally attributed to more common causes.33-35 In partial-body irradiation, published studies have recommended a mean dose of less than 18 Gy for the bilateral kidneys to limit renal toxicity. A quantitative analysis of normal tissue effects in a clinical review showed that a mean dose of 18 Gy and 28 Gy for the bilateral kidneys was associated with a 5% and 50% risk of radiation-induced kidney injury at 5 years, respectively.36 In addition, a recent study including 663 patients with stomach cancer demonstrated that the kidney V20 was an important predictive factor for renal insufficiency and that maintaining a low kidney V20 could minimize the effect of radiation on the 5-year eGFR.37 Notably, there was a significant difference in the V20 to the right kidney between the 2 treatment plans in our study. There
is minimal evidence of increased toxicities in the duodenum or renal toxicities from these small changes in dosimetry. However, the core goal of radiation therapy is to deliver a prescribed dose to the gross tumor while minimizing irradiation exposure to the surrounding normal tissue.

Our study has several limitations. Most notably, in the absence of clinical records on duodenal and renal toxicities, it was difficult to determine the relationship between dosimetric data and the incidence of duodenal and renal complications. In addition, all data were measured manually, inevitably causing biases. Moreover, organ motion between the 2 CT scans leads to changes in the relative positions of the target volumes and OARs, resulting in uncertainties. Furthermore, perhaps it is more important to measure the distance from the IVC to critical structures (duodenum and right kidney) rather than measuring strictly the displacement of the IVC between the contrast and noncontrast scans. Finally, the differences were most significant in the right lateral direction, where we did not perform RTOG-recommended nonuniform delineation, which limits the interpretation of our findings. However, despite these limitations, our study provides the first specific data to compare the effect of volume changes in the IVC on para-aortic nodal CTV contouring and the dose to the OARs on an IV contrast scan and a noncontrast scan.

Conclusions

Compared with the noncontrast scan, marked expansion of the IVC on the IV contrast scan can lead to excessive para-aortic nodal CTV contouring and an overdose to the duodenum and right kidney, which may result in unexpected duodenal and renal toxicities in patients with cervical cancer treated with prophylactic EFRT. Future studies are needed to examine the relationship between dosimetric data and the incidence of duodenal and renal complications.

References


