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# Delineating the relationship between Point A prescription dose and pelvic lymph node doses in intracavitary high-dose-rate brachytherapy treatment of cervical cancer for use in low- and middle-income countries

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**ABSTRACT**

**PURPOSE:** To define the relationship between the Point A prescription dose and the dose delivered to various pelvic lymph node groups during high-dose-rate (HDR) brachytherapy treatment of cervical cancer. In less developed countries, brachytherapy is often done without three-dimensional image guidance, instead relying on plain radiography and prescription to Point A. A defined relationship between Point A dose and lymph node doses would help physicians in these health care settings to more accurately estimate nodal doses.

**METHODS AND MATERIALS:** Treatment data from 50 fractions of HDR brachytherapy of cervical cancer were reviewed, the pelvic lymph nodes were contoured, and dose−volume histogram parameters were obtained. Dose−volume histogram parameters for each contour were normalized as a percentage of the corresponding Point A dose. All nodal groups were divided into left and right sides, except the presacral nodal group.

**RESULTS AND CONCLUSIONS:** Mean Point A doses were bilateral (Bil) 5.92 Gy ± 0.58, left (L) 5.93 ± 0.59, and right (R) 5.92 ± 0.59. Mean normalized D90 values for the various lymph node groups were as follows—obturator: Bil 20.3% ± 4.5, L 20.5% ± 4.4, and R 20.2% ± 5.2; external iliac: Bil 9.5% ± 2.9, L 10.0% ± 3.1, and R 9.5% ± 3.0; internal iliac: Bil 12.2% ± 3.5, L 12.1% ± 3.4, and R 12.9% ± 4.7; common iliac: Bil 4.3% ± 1.6, L 4.3% ± 1.6, and R 4.3% ± 1.7; and presacral: 8.7% ± 3.4. These relationships can serve as a useful tool for evaluating lymph node doses during HDR brachytherapy of cervical cancer in facilities performing two-dimensional treatment planning and those with limited resources. 

*Keywords:* Cervical cancer; Lymph nodes; Pelvic lymph nodes; Nodal boost; Point A; Prescription dose

## Introduction

Carcinoma of the cervix is a disease that affects millions of women worldwide; it ranks as the fourth most frequent cancer in women globally (1). A combination of external beam radiation therapy (EBRT) and brachytherapy with concurrent chemotherapy is the standard of care in the treatment of locally advanced cervical cancer (2−6).

While prognosis is traditionally and largely determined by International Federation of Gynecology and Obstetrics staging, pelvic lymph node metastasis is an important prognostic factor in cervical cancer. Multiple studies have shown that the presence of lymph node metastasis is associated with both increased rate of recurrence and decreased survival (7−10). Therefore, adequate treatment of involved and at-risk lymph node−bearing regions is paramount in the curative management of locally advanced cervical cancer.

In many developed countries, the use of three-dimensional (3D) treatment software enables physicians to determine lymph node coverage during radiation treatment. Brachytherapy planning software can be used to contour pelvic lymph nodes and obtain the appropriate dose−volume histogram (DVH) data. In less developed countries without access to these technologies, or with significant time constraints, using

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software to determine lymph node doses is not a possibility. However, they are able to calculate Point A and Point B doses, which can be easily determined with the use of a simple pelvic x-ray (11).

If a reliable relationship between Point A dose and lymph node doses can be determined, this could serve as a substitute for 3D imaging modalities. It also aids the planning of lymph node boost doses to know what the expected brachytherapy contribution is to involved nodes. The purpose of this study is to establish the relationship between the Point A prescription dose and pelvic lymph node doses during high-dose-rate (HDR) brachytherapy to the cervix.

## Methods and materials

A total of 16 patients with varying stages of cervical cancer underwent computed tomography (CT)—based HDR brachytherapy at Loyola University Medical Center from 2009 to 2013. Patient data were retrospectively reviewed with approval from the institutional review board. Patients underwent four to five fractions of brachytherapy, depending on the individual clinical setting. Most patients were dosed to Point A without any subsequent 3D dose optimization, as dose optimization was not routinely used at this institution until 2013. Pelvic lymph nodes were contoured for each brachytherapy fraction with a viable CT scan. CT scans were considered viable if they extended inferiorly to the obturator foramen and superiorly to the bifurcation of the abdominal aorta—these criteria ensured that the pelvic lymph node groups of interest were included. Fifty analyzable fractions were included to comprise the final data set. The prescription dose for treatment sessions ranged from 5.0 to 7.0 Gy to Point A. All treatment sessions used a tandem and ovoid applicator. Transverse segment images of the pelvic area were viewed in 3-mm increments, and pelvic lymph nodes were contoured for each relevant image to create a 3D nodal volume for the various pelvic lymph node groups.

The pelvic lymph node contours were created after an extensive review of radiographic literature. Definitions of pelvic lymph node boundaries were created using the Radiation Therapy Oncology Group guidelines for delineating clinical target volume for intensity-modulated radiotherapy (IMRT) for postoperative endometrial and cervical cancers (12, 13). Some modifications were made to these guidelines using a previous study examining the correlation between Point B and pelvic lymph node dosage (14) and a study dedicated to defining the clinical target volume of pelvic lymph nodes during external beam radiotherapy of cervical cancer (15). Contours were created according to these modified guidelines as explained below and then reviewed sequentially by a radiation oncology resident (F.A.) and an attending physician (W.S.).

The common iliac, presacral, external iliac, internal iliac, and obturator lymph node groups were contoured. All nodal groups, except for presacral, were contoured as separate left- and right-sided structures with generation of a combined bilateral structure. Contours were created by adding a uniform 7-mm margin around the vessels with exclusion of muscle, bone, and bowel. The presacral contour was created by adding a 1.5-cm margin extending from the anterior aspect of the vertebral body. Detailed information regarding contouring of individual nodal groups is summarized in Table 1.

During treatment planning, Point A was defined as 2 cm superior to the superior aspect of the ovoids along the length of the intrauterine tandem and 2 cm lateral and perpendicular to the tandem. Left, right, and bilateral averages of Point A prescription dose were collected for each fraction.

To analyze each treatment session, various DVH parameters were collected for the five lymph node groups of

Table 1
Summary of the recommendations used to contour the pelvic lymph node groups

| Nodal group | Superior border | Inferior border | Comments |
|---|---|---|---|
| Common iliac | Bifurcation of the abdominal aorta (15) | Bifurcation of the common iliac vessels (12, 15) | - Split into left- and right-sided structures at the superior aspect of presacral contour (12).<br>- Bilateral contour split into left and right sides by anatomical midline. |
| Presacral | 2 cm inferior of aortic bifurcation (12) | First transverse image with clear visualization of the piriformis muscle (12) | - 1.5-cm margin extending from anterior portion of the vertebral body or sacrum (12).<br>- Extended laterally until reaching the borders of the common, external, or internal iliac contours.<br>- Not split into left- and right-sided volumes because it is a midline nodal bearing space |
| External iliac | Bifurcation of the common iliac vessels (12, 15) | Superior aspect of femoral head where the external iliac vessels become the femoral vessels (12, 15) | |
| Internal iliac | Bifurcation of the common iliac vessels (12, 15) | Roof of the acetabulum (12, 15) | Roof of the acetabulum was used as a surrogate to estimate the bifurcation of the obturator vessels off of the internal iliac vessels. At this level, the internal iliac contour ends, and the obturator contour begins. |
| Obturator | Roof of the acetabulum (14) | Fovea of the femoral head (14) | The obturator space is the triangular area between the internal and external iliac vessels. |