Original Article

An Atlas of the Pelvic Lymph Node Regions to Aid Radiotherapy Target Volume Definition

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ABSTRACT:

Aims: The implementation of advanced three-dimensional radiotherapy planning techniques requires accurate target volume localisation. We have previously developed guidelines to aid definition of the pelvic lymph node regions, and the aim of this study was to produce a CT atlas.

Materials and methods: The guidelines were applied to a CT scan of a patient to receive adjuvant radiotherapy.

Results: Reference CT images of the pelvis were generated, illustrating the nodal regions and a typical target volume for adjuvant pelvic radiotherapy for gynaecological cancer.

Conclusion: These images can be used as an aid for target volume definition of the pelvic nodal regions. Taylor, A. et al. (2007). Clinical Oncology [jj]. © 2007 Published by Elsevier Ltd on behalf of The Royal College of Radiologists.

Key words: Clinical target volume, conformal radiotherapy, intensity-modulated radiotherapy, iron oxide particles, pelvic lymph nodes, radiotherapy planning

Introduction

Accurate and reproducible delineation of target volumes is essential for effective three-dimensional radiotherapy. Pelvic lymph node irradiation has an important role in the management of many pelvic malignancies. Planning studies comparing intensity-modulated radiotherapy (IMRT) with conventional approaches have shown significant dosimetric advantages in gynaecological and urological cancer [1–3]. However, one of the factors limiting widespread implementation of the technique has been a lack of consensus on the target volume.

The probability of lymph nodes containing metastases is currently assessed using size criteria with computed tomography or magnetic resonance imaging (MRI). A nodal maximal short axis diameter of greater than 10 mm indicates a high risk of metastatic involvement, but the sensitivity of this method is only 40–70% [4–6]. Unenlarged nodes may still contain tumour deposits and it is therefore necessary to include all lymph nodes within the draining regions of the tumour in the clinical target volume (CTV). Most ‘normal size’ lymph nodes are too small to be directly visualised with standard imaging and delineation of the nodal CTV depends on their relationship to other pelvic structures.

Anatomical studies have shown that pelvic lymph nodes lie adjacent to the major pelvic blood vessels. These are relatively well visualised on conventional imaging and can, with an appropriate margin, be used as a surrogate target for lymph nodes. Ultra-small particles of iron oxide (USPIO) are a novel class of MRI contrast agent that make lymph nodes more readily visible [7,8]. We have previously reported a study with USPIO that assessed the position of the pelvic lymph nodes in relation to the blood vessels, and developed guidelines for outlining the lymph node regions [9]. These guidelines have been independently applied to a further series of patients and found to be effective in ensuring target volume coverage for >99% of nodes [10].

The purpose of this study was to use the guidelines to develop a generic computed tomography atlas showing the position of pelvic lymph nodes that could then be applied for three-dimensional radiotherapy planning techniques.

Materials and Methods

Radiotherapy planning computed tomography was used in a patient who was to receive postoperative radiotherapy to the pelvis, having previously undergone a simple abdominal hysterectomy and bilateral salpingo-oophorectomy for uterine cancer. The patient was scanned in the supine position with a full bladder, with 5 mm slice intervals from 2 cm above the aortic bifurcation to the lower limit of the inguinal region. Intravenous contrast was given to aid visualisation of the blood vessels. The images were transferred to a radiotherapy planning system (Eclipse v6.5, Varian).

Using pelvic blood vessels as a surrogate target for lymph nodes, our guidelines for delineation were applied (Table 1). First, a 7 mm margin was drawn around the pelvic blood
Lymph node group   | Recommended margins*  
---|---  
Common iliac | 7 mm margin around vessels. Extend posterior and lateral borders to psoas and vertebral body  
External iliac | 7 mm margin around vessels. Extend anterior border by a further 10 mm anterolaterally along the iliopsoas muscle to include the lateral external iliac nodes  
Internal iliac | 7 mm margin around vessels. Extend lateral borders to pelvic side wall  
Obturator | Join external and internal iliac regions with a 17 mm wide strip along the pelvic side wall  
Pre-sacral | Subaortic: 10 mm strip over anterior sacrum  
Mesorectal: cover entire mesorectal space  

*Also include any visible nodes.

Table 1 — Summary of the guidelines for delineating nodal regions

vessels. The following modifications were then made: in the common iliac region, the contour was extended posteriorly to the vertebral body, passing around the psoas muscle; to encompass the obturator region, the contours around the external and internal iliac vessels were joined to create a single volume on each side of the pelvis, ensuring that the width was at least 17 mm from the pelvic side wall; the upper pre-sacral region was covered with a 10 mm strip over the anterior sacral prominence; where the margin passed over muscle or bone, these structures were deleted from the CTV; and finally, to cover the distal lateral external iliac nodes, the volume was extended anterolaterally by a further 1 cm along the line of the iliopsoas muscle. The parametria and vaginal vault were also outlined as a separate structure.

Reference images were produced showing the typical target volume for adjuvant pelvic radiotherapy, including the common iliac, anterior and medial external iliac, internal iliac, obturator and the subaortic pre-sacral lymph node groups.

Results

The reference images produced by applying the guidelines are shown in Fig. 1. The typical target volume for adjuvant pelvic radiotherapy in gynaecological cancer has been outlined, and the nodal groups are indicated. The additional margin required for including the distal lateral external iliac nodes is shown in blue. The parametrium and the upper vagina are shown in red, and the inguinal, pre-sacral and lower para-aortic nodal regions are also indicated.

Discussion

Conformal radiotherapy is increasingly recognised as offering benefit in normal tissue sparing in whole pelvic irradiation. IMRT offers even greater potential for normal tissue protection and dose escalation. The CTV usually comprises the primary tumour, or tumour bed, structures at risk of direct tumour spread, such as the parametrium, and the draining lymph node regions. The pelvic lymph nodes, however, are difficult to delineate as most cannot be visualised on computed tomography or MRI, but still may contain metastases. Because of greater conformity in all dimensions, consistent and accurate target volume definition is particularly important with IMRT, as salvage treatment for relapsed disease due to a geographical miss is rarely successful [11].

With the complexity of dose pattern that can be achieved with IMRT, it is now possible to select which nodal groups need to be covered depending on tumour site and stage. The proposed guidelines have been applied to generate an atlas of reference images defining each of the pelvic lymph node regions and enabling standardisation of the target volumes for IMRT. It must be emphasised that there are no pathologically enlarged nodes on these images, and it is still important to ensure that all visible nodes are fully encompassed by the CTV, as nodes with a diameter greater than 8 mm are readily identified with computed tomography.

For gynaecological cancers, the nodal CTV would typically include the external iliac, internal iliac and obturator nodes. Treatment of the common iliac region is indicated for tumours involving the cervix, or when there is lymphadenopathy in another pelvic region [12–15]. The distal lateral external iliac nodes often lie distant from the vessels, and studies have shown that despite being missed by conventional fields in 34–45% of cases, this region is a rare site of recurrence [16–18]. Therefore, these nodes do not need to be routinely encompassed and our practice would be to include them only if there is other external iliac nodal involvement, or if the target volume also includes the inguinal regions. The lower pre-sacral nodes are also included if there is tumour extension along the uterosacral ligaments or if there is rectal involvement. Although the images show the CTV for gynaecological cancer, it would not be unreasonable to extrapolate the results to male pelvic anatomy, and to use a similar target volume when treating pelvic nodes for urological cancer.

The selection of the appropriate nodal groups depends on existing data from surgical and autopsy series, but there will increasingly be more information available from functional imaging and from sentinel lymph node studies, which could help to refine or individualise the target volume. It will also be essential to collect data prospectively on the sites of pelvic recurrence in all patients treated with pelvic IMRT to assess whether future modification of the target volume is necessary.

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The typical clinical target volume (CTV) for adjuvant pelvic radiotherapy in gynaecological cancer contoured in yellow, and modifications shown to include lateral external iliac nodes (blue), inguino-femoral nodes (green) and the parametria and upper vagina (red). The nodal regions indicated are para-aortic (PA), common iliac (CI), pre-sacral (PS), internal iliac (II), obturator (Obt), lateral (EII), medial (Elm) and anterior (Ela) external iliac, parametrial and paravaginal (Pm), and inguino-femoral (Ing) lymph nodes.
Fig. 1 (Continued)
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References


