Does conformal therapy improve dose distribution in comparison to old techniques in teleradiotherapy of cervical cancer patients?

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SUMMARY

BACKGROUND: The use of a combined modality approach – chemotherapy and radiation therapy – in the treatment of patients with cervical cancer is associated with significant toxicity, mainly haematological and gastrointestinal. Conformal radiotherapy has the potential to deliver an adequate dose to the target structures while sparing the normal tissue. Both the radiation dose to the small bowel and the volume are factors known to influence the risk of complications.

AIM: The aim of this study was to determine whether the implementation of conformal modality can reduce the volume of normal tissue included in the RT field.

METHODS AND MATERIALS: 14 cervical cancer patients (FIGO IIB and IIIB) treated with conformal radiotherapy concurrently with cisplatin (40 mg/m^2) administration once a week were analyzed. According to ICRU 50 recommendations target volumes and the organs at risk were contoured on CT slices. For the gross tumour volume (GTV) the tumour of the uterus and cervix was traced. The clinical target volume (CTV) was defined as the vessels and lymph nodes from the obturator level to the aortic bifurcation, presacral region, and upper 1/3 of the vagina. The margin for planning target volume (PTV) was added. The normal tissue region included the small bowel, large bowel and bladder. Using a 3D system and multi-leaf collimator a four-field treatment plan was performed for each patient. All 14 patients were treated with radiotherapy using these conformal 3D plans. Additionally (just for study purposes) for each patient we prepared two simpler plans with (1) two-field: anterior-posterior (A-P) and posterior-anterior (P-A); and (2) four-field box techniques. Dose-volume histograms of target volumes and organs at risk were calculated for each three plans for every patient and compared. Analysis of variance was performed to compute the statistical significance.

RESULTS: There is no statistical difference between doses received by target volumes – in each plan PTV is covered by the 95% isodose. Significantly different volumes of critical organs were included in the treatment field, depending on radiotherapy technique (conformal 3D method vs AP–PA two-field method): rectum 96.82% vs 38.23%, bowels 61.37% vs 30.79%.

CONCLUSION: These data suggest that implementation of conformal radiotherapy can reduce the irradiated volume in all the contoured critical organs, especially the bowels, compared to old techniques.

KEY WORDS: conformal teletherapy, critical organs, cervical cancer

INTRODUCTION

In recent years important changes in the treatment of advanced cervical cancer have occurred due to implementation of modern conformal technologies in radiotherapy and addition of chemotherapy (chemoradiotherapy). The progress in diagnostic imaging (CT, MR), including functional imaging (PET,

SPET, SPECT) allows us to improve the precision of definition of tumour volume probably closer to the real tumour dimensions. Computer systems for dose calculation in tumour and healthy tissues integrated with modern linacs create room for methods of dynamic modulation of the radiation beam which may lead to therapeutic index improvement and have the potential for progress of treatment results. The dose delivered to the cervical tumour (GTV) together with the margin of potentially infiltrated tissue (CTV) and physical margin (PTV) is the sum of tele- and brachytherapy doses. The use of conformal radiotherapy allows us to deliver a high dose to the tumour while limiting the dose to the healthy tissues mostly to the bowels, bladder and rectum, considered to be critical structures in cervical cancer radiotherapy. Limiting the volume of healthy tissues seems to be especially important in combining radiotherapy with chemotherapy. Chemotherapy combined with radical radiotherapy is associated with higher toxicity. In a meta-analysis of 17 trials Green et al. [1] found higher haematological toxicity in radiochemotherapy compared to radiotherapy (8 of 16 trials). The authors also found more early gastrointestinal toxicities (G 3–4) in the radiochemotherapy group (9% vs. 4%). The rate of late reactions in the pelvis did not differ [1, 2, 3].

There is therefore increasing concern over adverse radiation effects. In addition, small bowel tolerance remains a key barrier to dose-escalation and potential gains in tumour control. Ways of minimizing the volume of small bowel irradiated are paramount [4].

AIM

The aim of the current analysis was to compare dose distribution in PTV and healthy critical organs using three radiotherapy techniques. Two of them were used in the past in our institution: 1/ two anterior-posterior opposite beams (AP-PA) 2/ the "box" technique in various radiotherapy techniques used in the past and nowadays. The third, conformal technique, is currently used.

MATERIAL AND METHODS

We have analyzed accepted treatment plans of 14 pts diagnosed with cervical cancer in stages IIb-IIIb according to the FIGO classification. Patients were treated in the Dept. of Oncological Gynaecology of the Great Poland Cancer Centre from Jan. to April 2005. The treatment was conformal teleradiotherapy with LDR brachytherapy (2 applications) together with weekly cisplatin 40 mg/m^2. Patients were qualified for treatment after clinical examination, lab tests, imaging tests (USG, CT), and PS assessment (0–2). Patients who needed para-aortal node irradiation were excluded from this study. Planning and delivery of radiotherapy was executed according to the same principles. After simulation (Varis) CT for planning purposes (every 5 mm) was performed. 6 patients additionally had MRI exams followed by MRI/CT fusion. GTV, CTV and PTV were defined with CT as well as critical organs: small and large intestine and urinary bladder. GTV confined primary cervical tumour, CTV1 was GTV plus 0.5 cm margin plus uterine corpus, parametria and 1/3 of the vagina; CTV2 (lymph nodes) was the retroperitoneal space with lymph nodes along the major vessels in the pelvis. PTV was obtained by adding a 1.5 cm margin to CTV1 and a 1.0 cm margin to CTV2. External beam planning was done with v. 6.5 (Varian Medical Systems, Palo Alto, USA).

For every patient a conformal plan was designed using 4 beams encompassing PTV (95–107%) with MLC shaping and this plan was applied for patients' treatment. All 14 patients were treated using the conformal 3D technique described above from Jan. to April 2005.

Two additional plans for each and every patient were prepared only for study purposes. These two plans were not used for treatment. These two "simulation plans" represented older, simpler techniques used in our department in the past. (1) The first was AP-PA (two opposite beams) encompassing the pelvis with the tumour. The inferior border was situated on the lower edge of the obturator foramina, side borders 1.5 cm – 2.0 cm laterally to the pelvic bones, upper border to the upper edge of the fifth lumbar vertebra. (2) The second "simulation plan" ("box") was based on 4 opposite beams, with borders as described for the AP-PA plan except for the anterior border situated on the anterior edge of the pubic symphysis and the posterior border between the