The difference of High-risk Clinical Target Volumes (HR-CTV) between Computed Tomography and Magnetic Resonance Imaging in **Cervical Cancer**.

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Abstract

Purpose: This study was carried out to evaluate the volume and dose of HR-CTV between CT and MRI in intracavitary brachytherapy of cervical cancer.

Materials and methods: Retrospective data from the MRI and CT imaging of the first application of fifteen patients with locally advanced carcinoma of cervix uteri were collected and evaluated in terms of volume-based concepts. The volume and D90 of HR-CTV of MRI was compared with the HR-CTV of CT with the concepts of the Groupe Européen de Curiethérapie - European Society for Therapeutic Radiology and Oncology (GEC-ESTRO).

Results: No statistical significance between the MRI and CT of HR-CTV was observed.
Conclusion: The volumes of HR-CTV of MRI versus CT were not statistically significant although the MRI yielded good tumor identification.

Keywords: cervix cancer, brachytherapy, target volume comparison

INTRODUCTION

Radiotherapy for carcinoma of the cervix composed of external beam radiotherapy and brachytherapy and the cumulative dose of 85-90 Gy is required for treatment. For brachytherapy, film-based planning has been used for a long time with the prescription of point As and limitation points of the International Commissural of Radiological Units (ICRU).[1] However, the film based treatment planning still questioned the real geometry of the tumor and the real position of organs at risk (OARs; bladder, rectum). Magnetic resonance imaging (MRI) emerged for use in the diagnostic aspect which introduced a new treatment era of radiotherapy by Hricak and Togashi in late 1980s. [2-3] With MRI images, the details of lesions and OARs were identified. The benefits of new imaging were adapted for use in external beam radiotherapy to be three-dimensional radiotherapy (3D-CRT) and intensity-modulated radiation therapy (IMRT). Many studies were published to support the benefits of IMRT in gynecological cancers and showed an improvement of target coverage and reduction of dosage to normal tissue. So the volume based concepts emerged and have been widely used in EBRT of gynecological cancers.[4-7] Nowadays, brachytherapy has moved to do the same in the development of new imaging to use in the planning process. As in EBRT, the concepts of gross tumor volume (GTV), clinical target volume (CTV) and organs at risk (OARs) were developed for use in volume-based planning of brachytherapy by the recommendations of the Groupe Européen de Curiethérapie – European Society for Therapeutic Radiology and Oncology (GEC-ESTRO). [8-9] In CT aspects, the data set of target lesion and OARs were provided but there was a lack of tissue discrimination. MRI showed good tissue discrimination but the use of MRI was limited in radiotherapy in many centers. In fact, the CT simulator was the primary equipment in many radiotherapy units. In 2009, our institution started the project of MRI-based brachytherapy in cervical carcinoma which was designed to perform both CT and MRI in the first application of brachytherapy. So this study was performed to compare the volume of HR-CTV of CT versus MRI and D90 of HR-CTV of CT versus MRI to confirm this hypothesis.

MATERIALS AND METHODS

Fifteen patients with cervical carcinoma were retrospectively included in the study. All patients received the external beam radiotherapy and brachytherapy. In EBRT, The dose of 45 Gy in 25 fractions was prescribed with 6-10 MV with additional parametrial boost in selected patients. Four times of brachytherapy application were planned for all patients with the dose of 7 Gy to D90 of high risk clinical target volume (HR-CTV) according to GEC-ESTRO recommendations.[8] At the first application, all patients were planned by MRI while CT was also performed due to planning guidance. CT planning was used in the second, third, and fourth applications. The data of MRI and CT at the first application of brachytherapy were collected. The image data sets were contoured with the same radiation oncologist with the PLATO system. The volume of HR-CTV of MRI was identified according to GEC-ESTRO recommendations [8] and for CT, adapted GEC-ESTRO recommendations by Viswanathan et al. of CT were used.[10] Figure 1 shows the HR-CTV of both CT and MRI of the same patient. Later, contouring of bladder, rectum and sigmoid colon were performed by a radiation oncologist. The treatment planning was performed using the PLATO planning system (Software BPS version 3.3.2, Eval version 3.0, Nucletron B.V., Veenendaal, Netherlands). All HR-CTV parameters of the MRI and CT were compared with each other by pair t-test using the Statistical Package for the Social Sciences (SPSS) version 13.0 software.

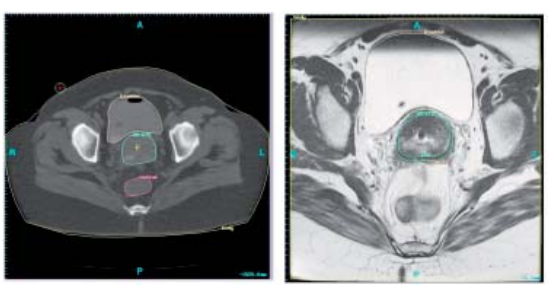

Figure 1 High-risk clinical target volume (HR-CTV) of a) CT and b) MRI of a 50 year old woman with stage IIB cervical carcinoma

RESULTS

After the treatment of the first BT was completed, all HR-CTVs from MRI and CT were evaluated. For the volume of HR-CTV, the mean volumes of CT versus MRI were 26.4 cm3 and 28.9 cm3, respectively. (p= 0.476) For the D90 of HR-CTV of both imaging modalities, the mean D90 of MRI (809 cGy) was slightly higher than D90 of CT (772 cGy) (p =0.435). The conclusions of the volume and dose comparisons are shown in Table 1.

DISCUSSION

Nowadays, the use of volume based treatment has emerged. The publication of GEC-ESTRO defined the target volume (high risk clinical target volume; HR-CTV/intermediate risk clinical target volume; IR-CTV) and organs at risk (bladder, rectum and sigmoid colon) using the MRI. [8] Moreover, the second publication of this group described the dose volume relationship of target lesions (HR-CTV/IR-CTV) and organs at risk (bladder, rectum and sigmoid colon) in terms of D90 (dose at 90% of volume) and D 2cc(dose at 2cc of volume), respectively. [9] With the MRI-based guidance, the treatment with brachytherapy became more specific. It allowed the optimization of the dose to HR-CTV and OARs which improved the clinical results.[10] Although the study from Viswanathan et al. showed that contouring with CT significantly produced a larger HR-CTV volume and a lower D90 than the MRI (MRI was not applicable in all institutions). [11] The study from Eskander et al showed the differences between target and normal tissue delineation between magnetic resonance imaging (MRI) and computed tomography (CT) in cervical cancer patients and explored the differences in dosimetries after brachytherapy planning. The MRI showed a significantly greater HR-CTV length in the sagittal plane (P = 0.006), with the CT showing a greater length in the coronal plane (P = 0.004). With volume optimization, no significant differences were seen between HR-CTV dose parameters. [12] These results were different to our study which showed no statistical significance between the volume of HR-CTV and D90 between CT and MRI. Although in a treatment aspect, these were the same, the MRI was still better in view of GTV and soft tissue discrimination. The CT simulator is equipped in our department for performing 3D-CRT and IMRT. For our study, the HR-CTV volume and D90 of MRI was not different from the CT.

CONCLUSION

The volumes of HR-CTV of MRI versus CT did not show a statistically significant difference although the MRI yielded good tumor identification. The volume and D90 of HR-CTV were not significantly different.

Table 1: The volumes and D90 of HR-CTV of MRI and CT

Parameters	HR-CTV of MRI	HR-CTV of CT	p-value
V HR-CTV (cm^3)			
Mean	28.907	26.393	
Median	21.3	23.2	0.476
Standard deviation	24.068	13.676	
D90 of HR-CTV (cm^3)			
Mean	809	772.27	
Median	760	783	0.435
Standard deviation	164.3	127.83	

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