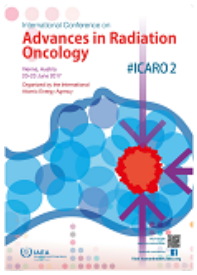

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Comparison of points and volumetric doses using CT and MR images for 3D planning brachytherapy: A Brazilian experience

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Introduction
Uterine cervix cancer, one of the most common tumors in the female population worldwide, is where brachytherapy plays a major role for local control and survival of these patients. Due the high dose-gradient of brachytherapy, it is possible to achieve the major challenge in radiation therapy to treat lesions with a high effective dose, while minimizing the dose in adjacent normal tissue or organs at risk (OAR). Image-guided (IGBT) or 3D gynaecological brachytherapy, that uses plans based on computed tomography or magnetic resonance has the potential to improve local control and survival in these patients, since it is possible evaluate the dose volume and then optimize the cost-benefit ratio between dose at tumor and organs at risk.

Materials and Methods
Alternated magnetic resonance images (MRI)and computed tomographies (CT)were performed for 12 patients that were treated for cervix cancer with 2D planning brachytherapy from April to September of 2010 using ring and tandemCT/MRI compatible applicator Nucletron®. Totally, 23 CT and 22 MR acquisitions were made after the insertion and fixation of the applicator in a specific support. The patients were then immobilized with the applicators in place in a vac-fix.
For treatment, bladder was fulfilled with 50 cm3 of saline solution and a urinary catheter with a balloon with 5 cm3 of saline solution and 2 cm3 of contrast solution.
3D plans were performed on TPS OncentraMasterPlanNucletron®, using TC and MR images and applicatorsreconstruction were based on applicators library and prescription dose was 7 Gy at point A. However, this system was not commissioned at the beginning of this work, in such a way that all patients were treated with 2D planning performed on TPS Plato Nucletron®.
The 2D evaluation points, ICRU points (ICRU 38, 1999), bladder (ICRUBladder) and rectum (ICRURectum), and sigmoid point (Sig) (Guimarães, et al, 2009) were added in 3D images in order to compare to a dose volume in each organ at risk (OAR). The volumetric comparison was made for 0.1 cm3 (D0.1cc) and 2 cm3 (D2cc) (Pötter, et al, 2006).

Results
The data analysis showed that CT and MRI based plans were statistically equal when comparing dose delivered to OAR´s, so the comparison was made using all data. Table 1 presents the results of the comparison of points and volumes doses.

Table 1: Comparison of points and volumetric doses for OAR´s in CT and MRI based plans.
The dose delivered to points in 2D plans was different from the volumetric dose in the OAR´s ($p<0.05$). The bladder point received dose lower than the volumetric dose for this specific organ, because when fulfilled, the bladder falls over the applicator in a high dose region while the vesical balloon stays in a low dose region.
Even if the bladder point doesnot estimate the volumetric dose, it is still important to use this point when 2Dplans are performed in order to try to decrease the dose delivered to the bladder.
The dose delivered to the rectum point was higher than the dose delivered to 0.1cc and lower than dose delivered to 2 cc, probably due to the fact that the rectum is an organ with less mobility. Therefore the rectum point is more representative of volume dose.
The sigmoid is an organ with high mobility and the sigmoid dose point did not correspond to the volumetric dose for the organ.

Conclusion
3D plans based on CT or MRIfor brachytherapy can help to spare OAR. In terms of OAR´s dose evaluation, the use of CT or MR showed to be equivalent. As consequence, both of them can be used to decrease volumetric dose at OAR´s. Since the points used in 2D plan did not show great correlation to volumetric dose, D0.1cc and D2cc respectively, the implementation of a 3D planning for brachytherapy seems to be very promising in order to improve gynecological brachytherapy treatment.

Country

Brazil

Institution

Departamento de Radiologia e Oncologia - InRad –Radioterapia, HCFMUSP, Sao Paulo, Brazil

Author: PESSOA DE SALES, Camila (Hospital das Clínicas da Faculdade de Medicina da Universidade de São Paulo)

Co-authors: CARVALHO, Heloisa Andrade (Departamento de Radiologia e Oncologia - InRad –Radioterapia, HCFMUSP, São Paulo, Brasil); RODRIGUES, Laura Natal (heloisa.carvalho@hc.fm.usp.br)

Presenter: PESSOA DE SALES, Camila (Hospital das Clínicas da Faculdade de Medicina da Universidade de São Paulo)

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