Dose differences between two-dimensional and three-dimensional approach to high dose brachytherapy dose reporting of organs at risk in inoperable cervical cancer treatment

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Introduction

Definitive treatment protocols of inoperable cervical cancer utilize radiotherapy
In a form of external beam (EBRT) and brachytherapy (BT).
Usually EBRT is applied in a form of concurrent chemo-radiotherapy (CCRT), followed by BT. Radiotherapy goal is to achieve a cumulative dose of 80 to 85 Gy into the target volume while obtaining optimal dose reduction in organs at risk (OAR).
Maximal tolerant doses in OAR volume of 2 ccm are 95(±22) Gy (α/β=3) for bladder and 65(±12) Gy (α/β=3) for rectum respectively.
Dose constrains in two-dimensional (2D) dose planning are calculated as a percentage of applied brachytherapy dose to point A, i.e. 80% for bladder and 70% for rectal dose constrain.
Cumulative 2D dose constrains for the whole BT treatment (cumulative brachytherapy dose of 21 Gy) are 16.8 Gy for bladder and 14.7 Gy for rectum.

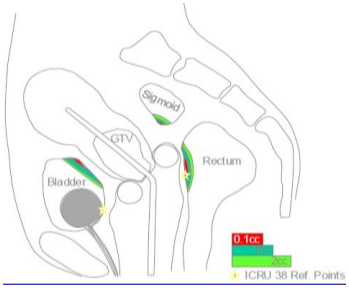
Results – DVH values / ICRU reference points

Bladder	
D_{2cc}	95 (±22) $Gy_{\alpha\beta3}$
$D_{0.1cc}$	162 (±75) $Gy_{\alpha\beta3}$
ICRU point dose	72 (±15) $Gy_{\alpha\beta3}$
Rectum	
D_{2cc}	65 (±12) $Gy_{\alpha\beta3}$
$D_{0.1cc}$	86 (±27) $Gy_{\alpha\beta3}$
ICRU point	67 (±13) $Gy_{\alpha\beta3}$
Sigmoid	
D_{2cc}	62 (±12) $Gy_{\alpha\beta3}$
$D_{0.1cc}$	78 (±12) $Gy_{\alpha\beta3}$

Biologically weighted to 2 Gy/fraction, α/β=3 Gy
Based on 145 patients with individual MRI based treatment plans (Vienna) (Georg et al. 2011 IJROBP)

Material and methods

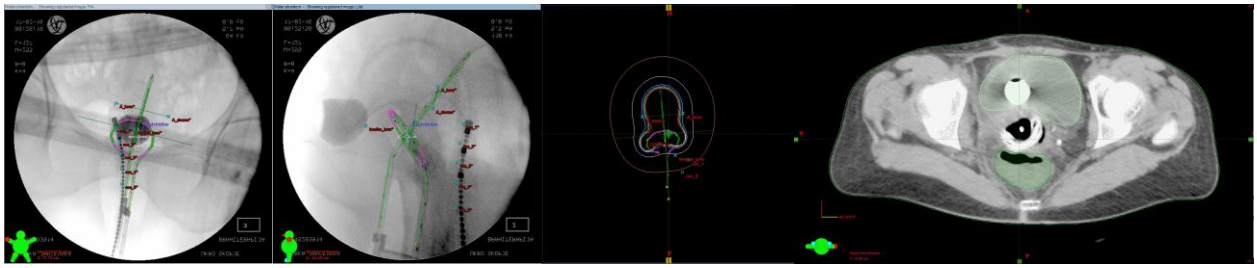
16 patients were analyzed (total of 48 applications) with diagnosed inoperable cervical cancer.
All patients prior have received CCRT total dose of 50.4 Gy in 28 daily fractions (5 days/week) along with weekly applied Cisplatin (for the duration of 5 weeks).
HDR BT was applied in 3 consecutive weekly applications with target dose of 7 Gy to point A per application (total of 21 Gy for the whole BT treatment).
We used GammaMedPlus™ an Ir-192 apparatus, patients were positioned on C-Arm for 2D and a computer tomography scanner for 3D planning.
Brachytherapy contouring and planning used DICOM and BrachyVision software.



Results

Bladder dose reporting for 2D planning gave an average dose (to bladder point) of 7.79 Gy per application (2.10 - 28.61 Gy) and an average of 23.37 Gy for the whole BT treatment (9.00 Gy – 68.06 Gy). 3D dose was reported in OAR volume of 2 ccm and showed an average of 5.08 Gy per application (1.70 Gy – 13.60 Gy) and 15.25Gy for the whole BT treatment (6.78 – 31.4 Gy).
Rectal dose reporting for 2D planning showed an average dose of 4.48 Gy per application (1.83 – 9.62 Gy) and an average dose of 13.45 Gy (6.33 – 22.49 Gy) for the duration of whole BT treatment. 3D dose was also reported in OAR volume of 2 ccm and the average dose per application was 3.38 Gy (1.50 – 6.53 Gy). For the whole BT treatment cumulative 3D rectal dose was 10.13 Gy in average (5.57 – 15.37 Gy).

Patients that received higher than dose constrains received corticosteroid and anti-inflammatory drugs.
All patients that developed mild to average irradiation side-effects such as cystitis and proctitis were successfully treated.



Conclusion

3D dose (in volume) dose reporting offers combined dose/volume display, which gives information about the OAR location and volume where the dose is actually absorbed. Smaller dose-affected OAR volume – should be linked to reduced radiation toxicity.
While short term side-effects may vary, long term side-effects should correlate with lower degree of radiotherapy treatment late toxicity.