REPORTS OF PRACTICAL ONCOLOGY AND RADIOTHERAPY 20 (2015) 365–369

Available online at www.sciencedirect.com

ScienceDirect

journal homepage: http://www.elsevier.com/locate/rpor

Original research article

Comparison of manual and inverse optimisation techniques in high dose rate intracavitary brachytherapy of cervical cancer: A dosimetric study

Ram Abhinav Kannan, Janaki Manur Gururajachar, Arul Ponni, Kirthi Koushik, Mohan Kumar, Ram Charith Alva, Ritika Harjani, Arvind Murthy*

Department of Radiation Oncology, M.S. Ramaiah Medical College, Bangalore 54, India

ARTICLE INFO

Article history:
Received 29 September 2014
Received in revised form
2 March 2015
Accepted 24 May 2015

Keywords:
Carcinoma cervix
Manual Optimisation
Inverse planning
High dose rate

ABSTRACT

Aims and objectives: To compare dosimetrically the manual optimisation with IPSA using dose volume histograms (DVH) among patients treated for carcinoma of cervix with intracavitary brachytherapy.

Background: With the advent of advanced imaging modalities, there has been a shift from conventional X-ray based planning to three-dimensional planning. Manual optimisation is widely used across various institutions but it is time consuming and operator dependant. Inverse planning simulated annealing (IPSA) is now available in various brachytherapy planning systems. But there is a paucity of studies comparing manual optimisation and IPSA in treatment of carcinoma cervix with intracavitary brachytherapy and hence this study.

Materials and methods: Fifteen consecutive patients treated between December 2013 and March 2014 with intracavitary brachytherapy for carcinoma of cervix were selected for this study. All patients were initially treated with external beam radiotherapy followed by intracavitary brachytherapy. The DVH was evaluated and compared between manually optimised plans and IPSA in the same set of patients.

Results: There was a significant improvement in the HRCTV coverage, mean V100 of 87.75% and 82.37% ($p = 0.001$) and conformity index 0.67 and 0.6 ($p = 0.007$) for plans generated using IPSA and manual optimisation, respectively. Homogeneity index and dose to the OARs remained similar between the two groups.

Conclusion: The use of inverse planning in intracavitary brachytherapy of cervix has shown a significant improvement in the target volume coverage when compared with manual planning.

© 2015 Greater Poland Cancer Centre. Published by Elsevier Sp. z o.o. All rights reserved.

* *Corresponding author*. Tel.: +91 9916908494.
E-mail address: dr.ramabhinav@gmail.com (R.A. Kannan).

http://dx.doi.org/10.1016/j.rpor.2015.05.003
1507-1367/© 2015 Greater Poland Cancer Centre. Published by Elsevier Sp. z o.o. All rights reserved.

1. Background

Brachytherapy has been a standard component of definitive radiation therapy for cervical cancer since shortly after the discovery of radium. Intracavitary brachytherapy is the most commonly used brachytherapy technique in patients with cervical cancer. With advancements in dose optimisation and with the advent of advanced imaging modalities, there have been various evolutions of this technique overcoming a number of limitations.

With the use of computerised tomography scanning (CT scan), three-dimensional planning is feasible by direct visualisation of target volumes and critical structures with respect to the applicators. Customised dose distributions are now possible that may improve local control and reduce complications when compared to conventional two-dimensional brachytherapy planning.

With advances in imaging, the optimisation methods also have improved. Manual optimisation is a trial and error method where the planner keeps changing the dwell weights until an optimal solution is obtained. It allows the user to change the dwell weights manually or mouse drag the isodose lines such that the target coverage is adequate with maximal sparing of organ at risk (OAR). It is time consuming and planner dependant.

The recent advance in optimisation is the use of inverse planning simulated annealing (IPSA), which is based on a mathematical algorithm where clinical objectives are defined as mathematical equations. The optimal solution is obtained through iterative process by minimising the objective function.

In many centres, including our institution, the CT scan is shared with a radiology department. In a high volume centre like ours, there is usually a simulation delay of 3–4 h from the time of applicator placement to the time when first fraction of brachytherapy is delivered. This also includes 30–45 min of planning if manual optimisation is used. If the plans generated by IPSA are found to be comparable with manual optimisation plans, this could potentially reduce the time required for brachytherapy planning and could lead to earlier delivery of the next fraction.

2. Aim

To compare dosimetrically, manual optimisation with inverse planning simulated annealing using dose volume histograms (DVH) among patients treated for carcinoma of cervix with intracavitary brachytherapy.

3. Materials and methods

Data set of 15 consecutive patients treated between December 2013 and March 2014 with intracavitary brachytherapy for carcinoma of cervix was selected for this dosimetric study. All fifteen patients belonged to the International Federation of Gynecology and Obstetrics (FIGO) stage II. All patients were initially treated with external beam radiotherapy to a dose of 45 Gy in 1.8 Gy per fraction. After a gap of 7–10 days this was followed by intracavitary brachytherapy to a dose of 26 Gy in four equally divided fractions over two days with a minimum interfraction duration of 6 h. CT scan compatible tandem and ovoids were inserted after spinal anaesthesia with aseptic precautions after examination under anaesthesia. Image acquisition for treatment planning was done after the insertion of applicators using axial CT scans of 3 mm slice thickness. The images were transferred to Brachytherapy planning system (HDR plus v3.0) which also has the ability to perform IPSA in addition to manual optimisation. Contouring of High Risk Clinical Target Volume (HRCTV), Intermediate risk Clinical Target Volume and OARs were according to GEC-ESTRO guidelines[1] and Viswanathan et al.[2] Brachytherapy was delivered using BEBIG Brachytherapy system (Eckert & Ziegler) using Cobalt-60 sources.

High dose rate (HDR) brachytherapy system became available in our department from December 2013 and all patients treated between December 2013 and March 2014 was planned using the manual optimisation technique. Initially, a uniform dwell-time of 1 s was prescribed to all activated portions of the applicator. The active dwell weights were changed by clicking the isodose line and mouse dragging it to the desired location to cover the HRCTV. Alternately, the dwell weights of those positions contributing to dose to the OARs were reduced. This was done repeatedly until a satisfactory plan was obtained with respect to HRCTV coverage and OARs. Emphasis was put on limiting the dose to the OARs (D2cc rectum: 4 Gy, D2cc bladder: 5 Gy) while trying to adequately cover the HRCTV. The dose volume parameters were noted.

To compare IPSA with manual optimisation, inverse planning was done for the same fifteen patients who were treated previously after manual optimisation. Dose constraints were set to OARs and HRCTV. IPSA was used to generate an inverse plan, which identifies the combination of dwell times that best conforms to dose constraints of HRCTV and OARs. No manual optimisation was allowed. The relative weightage and dose constraints were changed until an optimal plan was obtained that meets the dose objective parameters of both target volume and OARs.

The following dose volume parameters were compared between the two optimisation methods: (1) D100 and D90 for the minimum doses to 100% and 90% volumes of HRCTV;(2) V100, V150, V200 and V300 for the volumes of HRCTV enclosed by 100, 150, 200 and 300% of the prescribed dose; (3) volumes covered by 100% (VPD) and 200% (V2PD) of the prescription dose; (4) D2cc bladder – maximal dose received by 2cc of bladder; (5) D2cc rectum – maximal dose received by 2cc of rectum; (6) conformity index (COIN); and (7) homogeneity index (HI).

COIN and HI were calculated using the formula:

$$\mathrm{COIN} = c_1 \times c_2 \times c_3$$

The coefficient c_1 describes how accurately the target volume is covered by a reference dose D_{ref}, i.e. PD.

$$c_1 = \frac{V_{\mathrm{ref,TV}}}{\mathrm{TV}}$$

where $V_{\mathrm{ref,TV}}$ is the volume of a reference dose covering the target volume and TV is the target volume. The ideal value of c_1 is equal to 1.

Download English Version:

https://daneshyari.com/en/article/1854178

Download Persian Version:

https://daneshyari.com/article/1854178

Daneshyari.com