Available online at www.sciencedirect.com

ScienceDirect

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

Original research article

Is volumetric modulated arc therapy with constant dose rate a valid option in radiation therapy for head and neck cancer patients?

Annamaria Didona[a], *Valentina Lancellotta*[b,*], *Claudio Zucchetti*[c], *Bianca Moira Panizza*[d], *Alessandro Frattegiani*[d], *Martina Iacco*[c], *Anna Concetta Di Pilato*[c], *Simonetta Saldi*[b], *Cynthia Aristei*[b]

[a] *Phys, Medical Physic Unit, Grosseto General Hospital, Grosseto, Italy*
[b] *Radiation Oncology Section, Department of Surgical and Biomedical Sciences, University of Perugia and Perugia General Hospital, Perugia, Italy*
[c] *Phys, Medical Physics Unit, Perugia General Hospital, Perugia, Italy*
[d] *Radiation Oncology Division, Perugia General Hospital, Perugia, Italy*

ARTICLE INFO

Article history:
Received 19 September 2017
Received in revised form
17 January 2018
Accepted 16 February 2018

Keywords:
Head and neck radiation therapy
Intensity modulated radiotherapy
Constant dose rate VMAT
Volumetric-modulated arc therapy

ABSTRACT

Background: Intensity-modulated radiotherapy (IMRT) improves dose distribution in head and neck (HN) radiation therapy. Volumetric-modulated arc therapy (VMAT), a new form of IMRT, delivers radiation in single or multiple arcs, varying dose rates (VDR-VMAT) and gantry speeds, has gained considerable attention. Constant dose rate VMAT (CDR-VMAT) associated with a fixed gantry speed does not require a dedicated linear accelerator like VDR-VMAT. The present study explored the feasibility, efficiency and delivery accuracy of CDR-VMAT, by comparing it with IMRT and VDR-VMAT in treatment planning for HN cancer.
Methods and materials: Step and shoot IMRT (SS-IMRT), CDR-VMAT and VDR-VMAT plans were created for 15 HN cancer patients and were generated by Pinnacle^3 TPS (v 9.8) using 6 MV photon energy. Three PTVs were defined to receive respectively prescribed doses of 66 Gy, 60 Gy and 54 Gy, in 30 fractions. Organs at risk (OARs) included the mandible, spinal cord, brain stem, parotids, salivary glands, esophagus, larynx and thyroid. SS-IMRT plans were based on 7 co-planar beams at fixed gantry angles. CDR-VMAT and VDR-VMAT plans, generated by the SmartArc module, used a 2-arc technique: one clockwise from 182° to 178° and the other one anti-clockwise from 178° to 182°. Comparison parameters included dose distribution to PTVs (D_{mean}, $D_{2\%}$, $D_{50\%}$, $D_{95\%}$, $D_{98\%}$ and Homogeneity Index), maximum or mean doses to OARs, specific dose-volume data, the monitor units and treatment delivery times.

* *Corresponding author at*: Radiation Oncology Section, Department of Surgical and Biomedical Science, University of Perugia and Perugia General Hospital, Ospedale Santa Maria della Misericordia, Sant'Andrea delle Fratte, 06156 Perugia, Italy.
E-mail address: valentina.lancellotta@unipg.it (V. Lancellotta).
https://doi.org/10.1016/j.rpor.2018.02.007
1507-1367/© 2018 Greater Poland Cancer Centre. Published by Elsevier Sp. z o.o. All rights reserved.

Results: Compared with SS-IMRT, CDR-VMAT significantly reduced the maximum doses to PTV1 and PTV2 and significantly improved all PTV3 parameters, except $D_{98\%}$ and $D_{95\%}$. It significantly spared parotid and submandibular glands and was associated with a lower D_{mean} to the larynx. Compared with VDR-VMAT, CDR-VMAT was linked to a significantly better D_{mean}, to the PTV3 but results were worse for the parotids, left submandibular gland, esophagus and mandible. Furthermore, the D_{mean} to the larynx was also worse. Compared with SS-IMRT and VDR-VMAT, CDR-VMAT was associated with higher average monitor unit values and significantly shorter average delivery times.

Conclusions: CDR-VMAT appeared to be a valid option in Radiation Therapy Centers that lack a dedicated linear accelerator for volumetric arc therapy with variable dose-rates and gantry velocities, and are unwilling or unable to sanction major expenditure at present but want to adopt volumetric techniques.

© 2018 Greater Poland Cancer Centre. Published by Elsevier Sp. z o.o. All rights reserved.

1. Background

Radiation therapy for head and neck cancer is challenging because of the complex anatomy of the region as tumors are often located in close proximity to crucial structures at high risk of toxicity. Therefore, reducing the dose to these organs needs to be balanced against appropriate coverage of target volumes. Head and neck tumors were conventionally treated with 3-dimensional (3D) conformal radiotherapy which has been replaced by intensity-modulated radiotherapy (IMRT). The latter improves target volume coverage sparing organs at risk (OARs) of toxicity.

In recent years, a new form of IMRT, i.e. volumetric-modulated arc therapy (VMAT), has gained considerable attention. It delivers radiation in single or multiple arcs, at varying dose rates (VDR-VMAT) and gantry speeds. VMAT was reported to be as good as IMRT in terms of target volume coverage and OAR sparing with the advantages of using fewer monitor units (MU) and taking less time to deliver treatments.[1–8] Consequently, the patient undergoes a shorter restriction time in the thermoplastic mask and treatment is safer with less risk of intra-fractional error. Furthermore, more patients can be treated in the Radiation Oncology Center.

VDR-VMAT requires a dedicated linear accelerator and treatment planning modules, all of which are costly. A cheaper option is constant dose rate VMAT (CDR-VMAT) associated with a fixed gantry speed because a dedicated linear accelerator is not required, although specific treatment planning software is.

The present study explored the feasibility, efficiency and delivery accuracy of CDR-VMAT and compared it with IMRT and VDR-VMAT in radiotherapy treatment plans for patients with head and neck cancer.

2. Methods and materials

A sample of patients with stage III–IV head and neck cancer was retrospectively selected from among those who had undergone IMRT at our Radiation Oncology Unit. Treatment plans were re-calculated (see below) for 15 patients (13 male, 2 female; age range 46–79 years of age, mean age 63 years, median 64; 5 had oropharyngeal cancer, 5 hypo-pharyngeal cancer and 5 larynx cancer).

2.1. Contouring and dose prescription

Computed tomography (CT) scans with 2.5 mm slice thicknesses were acquired from the top of the head to sternoclavicular junction. In the supine position with arms by their sides, each patient was wearing a customized head and neck immobilization thermoplastic mask. All CT scans were transmitted to the Pinnacle^3 treatment planning system (TPS) V9.8 (Philips Radiation Oncology Systems, Fitchburg, WI). Gross tumor volumes (GTVs, corresponding to the primary tumor and lymph node metastases) and clinical target volumes (CTVs) were contoured. OARs included the mandible, spinal cord, brain stem, parotid and submandibular glands, esophagus, thyroid and larynx (except for 5 patients with larynx cancer).

To obtain the planning target volumes (PTVs), GTVs were expanded by 1 cm and each CTV by 3 mm. Overlapping areas between PTVs and OARs were attributed to the PTV. To avoid the dose build-up effect, PTVs were restricted to 5 mm depth of the skin surface. Two rings surrounded each PTV. The 10 mm thick Ring1 constrained dose fall-off from the PTV while the 30 mm thick Ring 2 prevented hot-spots outside the targets.

Of all the OARs, only the spinal cord and brain stem were expanded by 5 mm to create planning risk volumes (PRV).

In accordance with RTOG guidelines,[9] treatment was delivered in 30 fractions. Prescribed doses in each patient were 66 Gy (2.20 Gy/fraction) for the high-risk volume (PTV1), 60 Gy (2.00 Gy/fraction) for the intermediate-risk volume (PTV2) and 54 Gy (1.8 Gy/fraction) for the low-risk volume (PTV3).

2.2. Treatment planning

Each patient was re-planned by the same physicist (AD) with CDR-VMAT and then with VDR-VMAT. The original IMRT plan and the new CDR-VMAT and VDR-VMAT plans were generated using 6 MV photon beam commissioned for a Varian Clinac 2100 DHX-S linear accelerator (Varian Medical Systems, Palo Alto, CA) equipped with the Millennium 120-leaves multileaf collimator (MLC). Version 9.8 Pinnacle^3 TPS calculated all treatment plans using the Pinnacle^3 SmartArc module for the CDR-VMAT and VDR-VMAT plans. The dose grid

Download English Version:

https://daneshyari.com/en/article/8201017

Download Persian Version:

https://daneshyari.com/article/8201017

Daneshyari.com