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Initial experience of hypofractionated radiation retreatment with true beam and flattening filter free beam in selected case reports of recurrent nasopharyngeal carcinoma

Filippo Alongi, Elena Clerici, Sara Pentimalli, Pietro Mancosu, Marta Scorsetti*

Radiotherapy and Radiosurgery Department, Humanitas Cancer Center, Istituto Clinico Humanitas, Via Manzoni 56, 20089 Rozzano, Milan, Italy

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ABSTRACT

Aim: To show our preliminary experience in using TrueBeam with RapidArc technology and FFF beam for stereotactic re-irradiation of nasopharyngeal carcinoma.

Background: Thanks to new advanced techniques, as well as intensity modulated radiation therapy, it is possible to approach head and neck recurrences in selected patients. Volumetric Modulated Arc Therapy (VMAT) in its RapidArc® format, permits to reduce significantly the time to deliver complex intensity modulated plans, allowing to treat hypofractionated regimes within a few minutes. With TrueBeam it is possible to perform photon beams without usage of the flattening filter. It seems possible to expect a reduction of out-of-field dose when flattening filter free (FFF) beams are used. While research into the physics domain for FFF beams is increasing, there are very few clinical data where FFF beams are applied in clinical practice.

Materials and methods: We present here the cases of 4 patients with local or regional recurrence of nasopharyngeal carcinoma. All patients were treated using TrueBeam with RapidArc technology and FFF beam for stereotactic hypofractionated re-irradiation.

Results: All patients concluded SBRT and showed good tolerability. During follow-up, complete response at imaging evaluation (PET and/or MRI) for all treated patients was documented.

Conclusions: Our preliminary experience using TrueBeam with RapidArc technology and FFF beam for stereotactic hypofractionated re-irradiation of nasopharyngeal carcinoma was safe and effective in all 4 treated patients. Longer follow-up and a larger population of study is needed to confirm these promising results.

1. Background

Systemic therapy is increasing survival in several subsets of patients with head and neck cancer. Locoregional recurrence remains the predominant pattern of failure after treatments in head and neck cancer patients; it also represents the most common cause of death.[1] Thus, local reirradiation is considered as a possible treatment option in case of recurrence in the site of disease.

* *Corresponding author*. Tel.: +39 0282248522; fax: +39 0282248509.
E-mail address: filippo.alongi@libero.it (F. Alongi).

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Radiation retreatment is a problematic issue to resolve in clinical practice: it requires knowledge on the possibility of unforeseen toxicity risks in healthy tissue. "Dose sculpting" on active tumor with IMRT is a helpful approach to minimize the radiation dose to previously irradiated tissues.[2] Image-guided radiation therapy (IGRT) reduces repositioning errors and is used to monitor the treatment region and/or to adapt dose distribution to the possibly changing target and organs at risk during radiotherapy.[3] Recently, two new technological platforms have been made available to clinical practice. Firstly, Volumetric Modulated Arc Therapy (VMAT) in its RapidArc® format permits to reduce significantly the time needed to deliver complex intensity modulated plans, allowing to treat hypofractionated regimes within a few minutes.[4] Secondly, there has been increasing attention on the clinical use of linear accelerators (LINAC) with photon beams generated without the usage of a flattening filter.[5–8] It seems possible to expect a reduction of out of-field dose when flattening filter free (FFF) beams are used.[33–36] This is mainly due to reduced head scatter and residual electron contamination. FFF beams should, therefore, lead to reduced peripheral doses and patients may benefit by decreased exposure of normal tissue to scattered doses outside the field. Removal of the flattening filter implies also the possibility to deliver treatments with higher dose rates, up to the factor 4 at 10 MV, and with a much higher dose per pulse. This, beside further improving time efficiency for delivery, might have subsequent potential radiobiologic implications still unclear and deserving dedicated investigations. While research into the physics domain for FFF beams is increasing, there are very few clinical data where FFF beams are applied in clinical practice,[32] particularly in stereotactic hypofractionated head and neck re-treatments.

2. Aim

We present herein our preliminary experience in 4 patients using TrueBeam with RapidArc technology and FFF beam used for stereotactic hypofractionated re-irradiation on local or regional recurrence of nasopharyngeal carcinoma.

3. Materials and methods

TrueBeam™ is a new LINAC designed to deliver flattened, as well as flattening filter-free (FFF) photon beams. In TrueBeam™, many key elements including the waveguide system, carousel assembly, beam generation, and monitoring control system differ from the preceding LINAC series as described in.[9] All patients were treated with RapidArc® using 10 MV FFF beams. The maximum dose rate enabled for FFF beams was 2400 MU/min for 10 MV. RapidArc® plans were individually designed using full or partial single or multiple arcs chosen to obtain the best adherence to planning objectives for each patient.[10] Treatment was delivered in 5 fractions in 3 patients with recurrence in nasopharynx region and in 18 fractions in one patient with lymph node relapse, both over consecutive working days. Treatment delivery included stereotactic frame localization and CBCT in the first session aiming at a preliminary isocentre positioning while for the following fractions, patient set-up was done by means of a daily CBCT image guidance with eventual on-line couch adjustment at each fraction. Image matching was performed on bones and, when visible, on tumors and other soft tissue structures. Clinical evaluations were planned on the first day of treatment, before radiation FFF session (visit 0); visit 1 in the course of the treatment; visit 2 at the end of the last session; visit 3 within 60–90 days from the end of the treatment. Unscheduled visits could be performed if necessary. Acute radiation induced toxicities were scored according to NCI Common Terminology Criteria for Adverse Events (CTCAE version 3.0).[11] A first assessment of treatment outcome, although obviously very early, was made at first and second follow up visits and are reported in terms of degree of response.

3.1. *Case 1*

Female patient, 41 years old. No other important concomitant diseases were recorded in anamnesis. In July 2007, a diagnosis of G2 carcinoma was made after a nasopharyngeal biopsy. Concomitant presence of neoplastic cells at needle aspiration exam in lateral right lymph node enlargement was confirmed. A cisplatin and 5-FU-based chemotherapy regimen was administered for two cycles and a partial response was shown at MRI after 2 months. A subsequent concomitant radiochemotherapy was performed, delivering 56 Gy by means of external beam radiotherapy to the whole neck and a boost by brachytherapy with doses of 9 Gy in 3 fractions. In 2009, CT detected local failure in the left nasopharyngeal region during follow-up. A biopsy confirmed the recurrence of nasopharyngeal Grade 3 carcinoma. Taxotere chemotherapy was administered for 6 cycles with further local progression shown on CT with contrast enhancement. In June 2010, a PET/CT confirmed the local failure with an exclusive FDG pathologic accumulation in the left region of the nasopharynx. In August 2010, Cetuximab was administered as salvage therapy. A CT for re-evaluation four months later showed further local progression of disease on the left side. In March 2011, the patient was referred to our Department of Radiotherapy and Radiosurgery where it was decided to re-irradiate the patient. PET/CT and MRI were used as imaging tools for image fusion with CT during a virtual simulation procedure. Stereotactic body radiotherapy was performed by means of TrueBeam with the RapidArc technique in 5 fractions of 6 Gy with a cumulative dose of 30 Gy. The treatment was completed without acute side effects. In June 2011, at the first clinical and instrumental evaluation during follow-up, PET/CT showed significant reduction of FDG accumulation in the treated area (see Fig. 1). No side effects were recorded. In September 2011, a complete metabolic response was shown at PET/CT and the same result of the absence of signs of recurrence/persistence was confirmed morphologically at the last MRI control in November 2011. During follow-up controls, the otorhinolaryngologist detected a congestion and thickening of the mucosa on the left side. With a minimum follow-up of 9 months, the patient is free of relapse and only moderate earache and sore throat were clinically recorded.