Available online at www.sciencedirect.com

ScienceDirect

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

Original research article

Dosimetric analysis of Co-60 source based high dose rate (HDR) brachytherapy: A case series of ten patients with carcinoma of the uterine cervix

Om Prakash Gurjar[a,*], *Manika Batra*[a], *Priyusha Bagdare*[a], *Sandeep Kaushik*[b], *Atul Tyagi*[b], *Ayush Naik*[a], *Virendra Bhandari*[a], *Krishna Lal Gupta*[a]

[a] *Roentgen-SAIMS Radiation Oncology Centre, Sri Aurobindo Institute of Medical Sciences, Indore, India*
[b] *Roentgen-BLK Radiation Oncology Centre, BLK Super Specialty Hospital, New Delhi, India*

ARTICLE INFO

Article history:
Received 29 July 2015
Received in revised form
10 November 2015
Accepted 21 January 2016
Available online 2 March 2016

Keywords:
Co-60 HDR brachytherapy unit
HDR Plus treatment planning system
High risk clinical target volumes

ABSTRACT

Aim: To analyse the dosimetric parameters of Co-60 based high dose rate (HDR) brachytherapy plans for patients of carcinoma uterine cervix.

Background: Co-60 high dose rate (HDR) brachytherapy unit has been introduced in past few years and is gaining importance owing to its long half life, economical benefits and comparable clinical outcome compared to Ir-192 HDR brachytherapy.

Materials and methods: A study was conducted on ten patients with locally advanced carcinoma of the uterine cervix (Ca Cx). Computed tomography (CT) images were taken after three channel applicator insertions. The planning for 7 Gray per fraction (7 Gy/#) was done for Co-60 HDR brachytherapy unit following the American Brachytherapy Society (ABS) guidelines. All the patients were treated with 3# with one week interval between fractions.

Results: The mean dose to high risk clinical target volumes (HRCTV) for D_{90} (dose to 90% volume) was found to be 102.05% (Standard Deviation (SD): 3.07). The mean D_{2cc} (dose to 2 cubic centimeter volume) of the bladder, rectum and sigmoid were found to be 15.9 Gy (SD: 0.58), 11.5 Gy (SD: 0.91) and 4.1 Gy (SD: 1.52), respectively.

Conclusion: The target coverage and doses to organs at risk (OARs) were achieved as per the ABS guidelines. Hence, it can be concluded that the Co-60 HDR brachytherapy unit is a good choice especially for the centers with a small number of brachytherapy procedures as no frequent source replacement is required like in an Ir-192 HDR unit.

* *Corresponding author at*: Roentgen-SAIMS Radiation Oncology Centre, Sri Aurobindo Institute of Medical Sciences, Indore 453111, India. Tel.: +91 8871883903.

E-mail addresses: ominbarc@gmail.com (O.P. Gurjar), manikabatra@ymail.com (M. Batra), pink2006@gmail.com (P. Bagdare), ri_ha@rediffmail.com (S. Kaushik), rosindoreresearch@gmail.com (A. Tyagi), ayushnaik@gmail.com (A. Naik), virencancer@yahoo.co.in (V. Bhandari), drklguptaindore@yahoo.com (K.L. Gupta).

http://dx.doi.org/10.1016/j.rpor.2016.01.003

Table 1 – Physical properties of Ir-192 and Co-60 radioisotopes.[5,6,10]

Properties	Cobalt-60	Iridium-192
Half life	5.26 years	73.8 days
Photon energy (MeV)	1.25 (mean)	0.38 (mean)
Half value layer (mm lead)	11	2.5
Exposure rate constant (R-cm^2/mCi-h)	13.07	4.69
Maximum specific activity (GBq/mg)	41.91	340.98
Inner length	3.5 mm	3.6 mm
Outer length	5 mm	4.5 mm
Inner diameter	0.5 mm	0.65 mm
Outer diameter	1 mm	0.9 mm

1. Background

Carcinoma of the uterine cervix (Ca Cx) is the fifth most common cancer worldwide, the second most common cancer in women and the most common cause of death in cancer patients in the developing countries. The most important risk factor for cervical intraepithelial neoplasia and invasive cervical cancer is the sexually transmitted human papilloma virus (HPV) infection.[1] The annual incidence of Ca Cx is approximately 510,000 new cases worldwide, with approximately 288,000 deaths.[2] The Ca Cx occurs in the reproductive period of a woman's life. The incidence rises in 30–34 years of age and peaks at 55–65 years, with a median age of 38 years (age 21–67 years).

Usually, the Ca Cx patients are treated with weekly chemotherapy concurrent with external beam radiotherapy (EBRT) for 50 Gray in 25 fractions (50 Gy/25#) at the rate of 2 Gy/#[3] followed by biological equivalent dose of 30–35 Gy by 3# of 7–8.5 Gy or 2# of 9 Gy by high dose rate (HDR) brachytherapy. Brachytherapy has an inverse square law as the most dominant physical effect, whereby radiation dose is inversely proportional to the square of the distance from the source. In practical terms, this allows for a very high dose to the tumor with relative sparing of the surrounding normal structures, which is the only demonstrated method of providing the high dose required to control Ca Cx (>80 Gy) without exceeding the dose tolerance of the bladder and rectum.[4]

Ir-192 HDR brachytherapy units has been used for a long time. Co-60 HDR unit has been introduced in past few years and is gaining importance owing to its long half-life. Co-60 with enhanced activity allows miniaturized sources that are equivalent to conventional Ir-192 sources (as shown in Table 1) with the same shape and diameter of applicators and similar application techniques.[6] The Co-60 and Ir-192 sources decay with different half-lives ($T_{1/2}$), the Co-60 source replacement is done after five years while Ir-192 source is replaced at every four months and both sources have different initial conditions. The variation in treatment time with time for the two sources is as shown in Fig. 1.[7]

Long half life of Co-60 provides relaxation in terms of repeated source replacement, documentation and administrative workload, specially related to competed authority, and thus, above all, it is economical as compared to Ir-192 HDR brachytherapy unit. Although, due to higher energy of Co-60 (1.25 MeV) than that of Ir-192 (0.38 MeV), the brachytherapy room with a larger wall thickness is required which increases the initial setup cost of Co-60 HDR brachytherapy unit.[8] Co-60 HDR brachytherapy offers a clinical outcome equivalent to Ir-192 HDR brachytherapy.[6,9] The physical properties of Co-60 and Ir-192 HDR brachytherapy sources are mentioned in Table 1.

2. Aim

To analyse the dosimetric parameters of Co-60 based high dose rate (HDR) brachytherapy plans for patients of carcinoma uterine cervix.

3. Materials and methods

The prospective study has been conducted on ten locally advanced Ca Cx patients. Approval from the institutional ethical committee was taken and consent from all the patients was received after explaining the pros and cons of the procedure. The selection criterion for the patients was histologically proven locally advanced Ca Cx stage III-b receiving concurrent chemoradiotherapy with Karnofsky performance status >70%. The patients who had undergone hysterectomy or with distant metastasis or other co-morbidities were excluded from the study.

The patients were initially given 50 Gy/25# with medical linear accelerator Clinac DMX (Varian Medical System Inc., Palo Alto, CA) along with concurrent chemotherapy with weekly injection cisplatin 40 mg/m^2 following which they were assessed for intra cavitary radiotherapy (ICRT). The patients with favorable anatomy for ICRT were included in the study and were planned for ICRT after one week from completion of EBRT.

To start with, the patient's fitness for procedure was assessed by the anesthetist. An ultrasonography (Phillips iu22, Bothwell, WA, USA) of the whole abdomen was done to assess the length and position of the uterus.

The necessary quality assurance (Q.A.) tests of HDR Brachytherapy unit (BEBIG GyneSource HDR, Eckert & Ziegler BEBIG, Germany) having Co-60 radioisotope (model Co0.A86, Eckert & Ziegler BEBIG, Germany) was done and then the patient was taken to the operation theater. The three channel applicator set (tandem and ovoids; Eckert & Ziegler BEBIG, Germany) was checked for its integrity. The patient was given a short general anesthesia. The patient was given anesthesia then she was put in a lithotomy position. The body parts in and near the vaginal region were cleaned and then draped. The length of the uterus was measured with the uterine sound. The appropriate length and position of the uterus was confirmed, the cervical os was dilated and the central tandem was inserted in the uterine cavity. After this, the ovoids with the lateral tandems were placed in the lateral fornices and fixed to the central tandem. This apparatus was held in position with the help of a T bandage tied to the abdomen. The patient was kept under observation for 15 min post procedure and then shifted for computed tomography (CT) scan of the pelvic area using Siemens SOMATOM definition AS scanner (Siemens Medical systems, Germany). CT images of 3 mm slice