A Study on Dosimetry of Gynaecological Cancer and Quality Assurance of HDR Brachytherapy in BPKMCH, Nepal

SB Chand, **PP Chaursia, MP Adhikary, AK Jha, and S Shrestha**

Dept. of Radiation Oncology, BPKM Cancer Hospital Chitwan, Nepal

ABSTRACT

Brachytherapy is the treatment of malignant lesion using radioactive isotopes near or inside the tumor. Brachytherapy is useful to deliver high radiation dose to the tumor and minimum possible to normal surrounding organs/tissue. The intention of this study was to do quality assurance of the cases that have undergone for the treatment in dept of radiation oncology, B.P.Koirala memorial cancer Hospital (BPKMCH) since last five year. The most practiced cases in our center are carcinoma of cervix and oesophagus in HDR Brachytherapy. Only Intracavitary brachytherapy (ICBT) cases were taken for this study. In total number 1341 patients has received ICBT from 2005 to 2009; out of them 1296 patients completed the treatments. Total 3941 applications were held during this period of study.

Key words— High Dose Rate Brachytherapy, ICRU-38 report, Remote after loading.

1. INTRODUCTION

Brachytherapy is a method of treatment in which sealed radioactive sources are used to deliver radiation at a short distance by interstitial, intracavitary, or surface application. With this mode of therapy a high radiation dose can be delivered locally to the tumor with rapid fall-off in the surrounding normal tissue. The history of Brachytherapy began in Paris in 1897.Shortly after Marie and Pierre Curie discovered radium in 1898, brachytherapy was first performed successfully to treat facial skin cancer[1]. This was done by directly applying a radioactive material such as radium, radon to the affected site. Within five years, radioactive sources were being used internally via an applicator inserted into the body. Since the technology is gradually progressing, the after loading methods were developed during 1959 and 1960 which offered protection from the radiation hazard to radiation workers performing Brachytherapy and there was greater flexibility of source geometry as well as improved reproducibility of treatment and comparatively shorter treatment time.[2] After the introduction of artificial isotopes, remote after loading devices, it has advantages of energy, source flexibility, source size, half life, reduced personal exposure. Three types of Brachytherapy are defined as dose rate: Low dose rate: 0.4 to 2 Gray/hr. Medium dose rate: 2 to 12 Gray/hr. High dose rate (HDR): more that 12 Gray/hr.[3] 137Cs (Cesium) is commonly used in LDR where as 192Ir (Iridium) and 60Co (Cobalt) are used in HDR brachytherapy. The use of Iridium for brachytherapy was developed though clinical experience in the treatment of uterine cervix, prostate, head and neck, oesophagus and skin cancer.

The use of HDR brachytherapy for cervical carcinoma is the result of technologic development in the manufacture of high intensity radioactive source, computerized remote after loading devices and treatment planning sysytem.[3] Optimization is used in various types such as dose point, dwell time, geometry based dose, volume time and equal time etc.[4]

External beam radiotherapy therapy and Brachytherapy are two main ways of delivering radiotherapy for cervical cancer. Usually external therapy is followed by Intracavitary brachytherapy. In the early stage of the disease only brachytherapy may be sufficient. External therapy is used to treat whole pelvis and the parametrium including lymph nodes. The aim of the study was to do quality assurance of the cases that have under gone for the treatment of carcinoma of cervix by HDR brachytherapy.

2. MATERIALS AND METHODS

Brachytherapy treatment has started with Varian Varisource HDR remote after loading (RAL) machine since 17 September 2002 in B.P.Koirala memorial cancer hospital (BPKMCH) in Bharatpur, Nepal. Varisource RAL device is a single source HDR after loading machine with a built in inactive wire called dummy wire which tests all connections before an actual treatment run is allowed. The maximum distal position of Varisource RAL is 150-cm, minimum step size is 4 mm, 20 cm continuous treatment and 1.5 cm minimum radius of curvature at 80 cm wire[5].After loader shielding material is Tungsten with maximum of 12 Curies Ir-192 shielding capacity.[10] Ir-192 is a solid single radioisotope of 5 mm length, 0.348 mm diameter, emits gamma rays of 380 KeV and a short half life of 73.83 days.
For carcinoma of cervix, we have delivered 40 Gy in 20 fraction(2Gy/# one fraction a day, 5 days in a week) the 10 Gy in 5 fraction with Mid Line Block (MLB) of external radiotherapy followed by 3 application of Intracavitary Radiotherapy (ICR) 7 Gy per fraction, one week interval between the ICRs. The Gynae- brachy table is used to for application in application room. Foley's catheter was inserted aseptically and 7 ml of radio opaque dye (urograffin) pushed into balloon that helped to locate bladder reference points. Rectal probe was inserted into rectum to identify rectum position on AP/LAT orthogonal films. The uterine sound was inserted in the uterine cavity to assess the length and position of the cavity. Uterine tandem was placed according to the length of uterine cavity and flange was fixed to remain at the external Os. Largest possible ovoid were placed in lateral fornices and fixed with the uterine tandem .The vaginal packing was done adequately with ribbon gauge. The Fletcher Suit Delclos FSD type of applicator was used for treatment of uterine cervix with intact uterus and vaginal cylinder for postoperative cases.[5]

Figure 1. Preparation of patients for external RT (left) and Brachytherapy (right)

Patient was shifted in simulator room to take orthogonal films. Applicators, bladder rectum position was observed and made needful adjustment before take the films.
Orthogonal films are taken in simulator room scanned through Vidar film digitizer scanner for planning the case in brachyvision treatment planning system. References points such as point A(2cm superior to external cervical Os and 2 cm lateral to cervical canal6), Bladder points, rectum points and point B (3 cm lateral to point A) were taken according to ICRU-38 reports.[2] Plan was done required dose to point A and as low as reasonably possible to rectum and bladder. Isodose curve shape, rectum, bladder dose was discussed. HDR Brachytherapy source calibration was done at the time of replacement of source wire. Before delivering the dose to patients the following Quality Assurance have been performed per day [7, 8, and 9]

We used Standard Imaging Inc electrometer CDX model and HDR 1000 plus well type ionization chamber with a volume 245 cm^3 source calibration. Current was noted at every source positioning in the well chamber.

Figure 2. Position verification (left) and source calibration (right)

3. RESULTS AND DISCUSSION:

Varisource Treatment Day QA Check lists

Perform door interlock test **Pass,** Perform door stop test **Pass**
Perform consol Stop test **Pass,** Perform consol key test **Pass**
Perform after loader key test **Pass,** Perform radiation monitor test **Pass**
Perform applicator inspection test **Pass,** Perform treatment room radiation test **Pass**
Perform obstruction detection test **Pass,** Perform catheter Misconnect test **Pass**
Perform position verification test, **Pass** Perform decay test **Pass**

The catheter position verification was done frequently with camscale and its deviation is within 0.01%.

Varisource strength calibration.
All new sources were calibrated to check source strength specified by the vendor.
Source strength = peak current reading x Ktp x calibration factor.

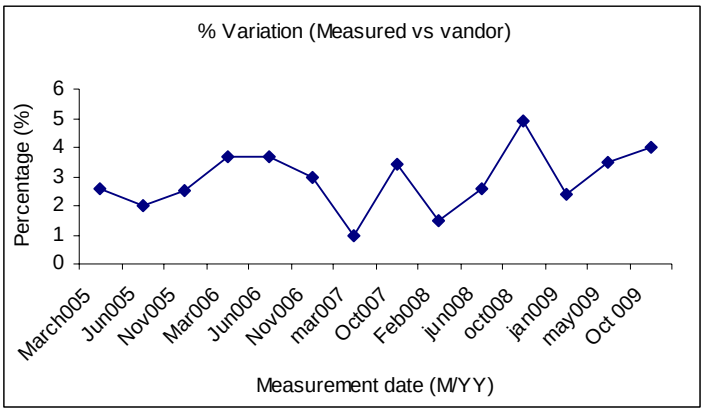

Figure 3 Source strength difference in vendor and site measured of different sources.

The difference, in percentage, between source strength measured at site and provided by varisource has calculated. Site measurement activities of different sources are seems similar to the vendor activities as shown in fig.3 and is within acceptable limit.

During the period of study 2005 to 2009, total 1341 intracavitary Brachytherapy (ICBT) patients, out of whom 1296 patients completed the treatments. Twenty eight received two and seventeen patients received only one Brachytherapy. In total, 3941 ICBT were held during the period of this study.

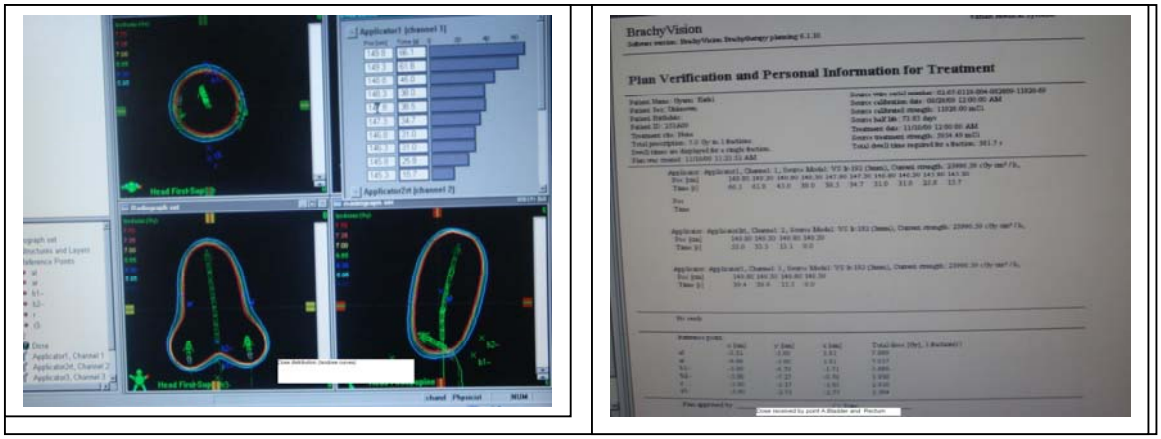

Figure 4 Isodose curves of ICBT planning (left) and dose at different points (right)

Bladder and Rectal dose

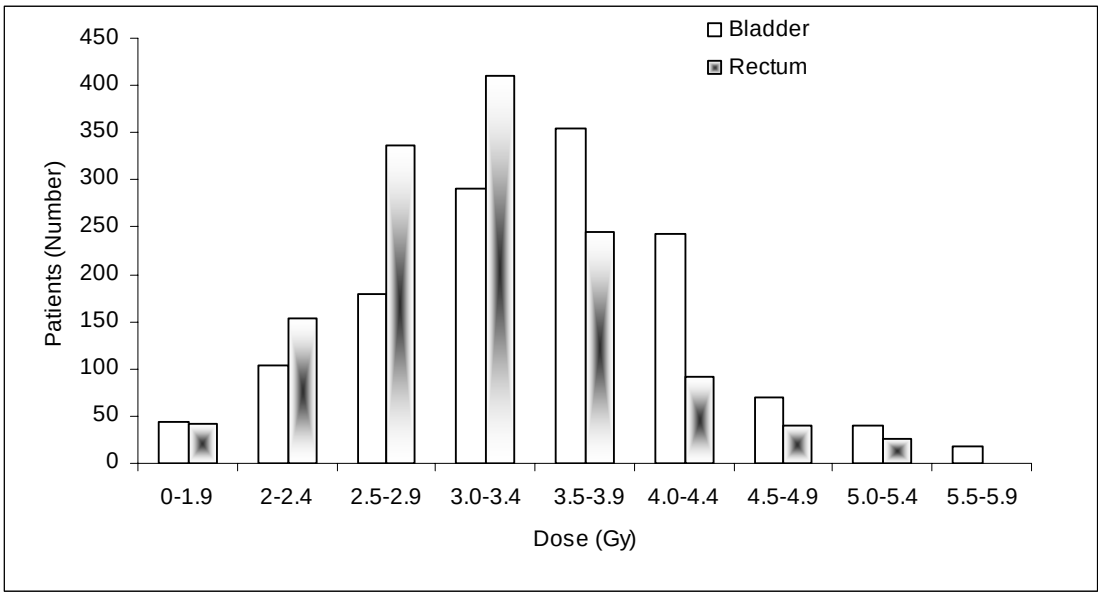

Figure 5. Bladder and rectal (centrally shaded) dose received by patients

1296 patients received all 3 cycle of treatments. Seven Gray was given in each ICBT. Maximum patients 888 (66.22%) are getting bladder dose between 3 to 4.4 Gy per treatment.

26.47 percentage patients has received dose to bladder in range of 3.5 to 3.9Gy . The bladder dose 72.5 percentage patients is less than 55.7 percentage of point A dose in each treatment.. Similarly; In case of rectum dose, total 1186 (89.2%) pts has received rectal dose less than 55.7 percentage of seven gray per cycle. 3.06 pts has rectal dose less than 2Gy and none have more than 5.5 Gy as in fig.5, centrally shaded chart. The peak of chart is 410 (30.58%) between 3-3.4 Gy which is less than 50 percentage of A point dose. The AP view of isodose curve is pear shaped. Most common stages of cervical cancer in our centre are of IIB and IIIB.[11] Higher the dose to bladder and rectum may cause of complication.
During the period of study new sources were calibrated in different dates. The variation between site measured and varisource sources strengths are in acceptable limit within five percentage.

4. CONCLUSION

The Most common malignancy in women in our dept of radiation oncology is cervical cancer. Radiotherapy has been considered an established effective treatment modality for all stage carcinoma of cervix. There is individualized treatment planning for every patient. Maximum patients were treated with bladder and rectal dose less than 55 and 50 percentages respectively of Point A dose with satisfactory pear shape. Normal organ dose should minimise, however, it should not produce a significant reduction in disease control.

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Address of the corresponding author:
Author: Surendra Bahadur Chand
Institute: B.P.Koirala Memorial Cancer Hospital
City: Bharatpur, Chitwan
Country: Nepal
Email: surendrachanda@yahoo.com