First Report on Study of Quality Control Program of High Dose Rate (HdR) Brachytherapy.

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ABSTRACT

INTRODUCTION: To evaluate the accuracy of radiation dose delivered to the cancer patients by using HDR Brachytherapy and to know the safety of radiation level for working personnel and public.

METHODE: The observation of sweet spots (maximum dose distribution) on different dates by using well chamber (SI HDR 1000) and electrometer (SI CDX 2000). On the basis of the observed sweet spot, Air Kerma Strength of the source is determined. Beside this includes the conformation of step size, radioactivity of the nuclides, safety measures of the machine. A careful radiation survey has been undertaken around the brachytherapy by using well calibrated radiation survey meter (FAG, FH 40F1).

RESULTS: Air Kerma strength in newly installed source exhibit small variation but within the limit. The step size has standard deviation 0.05 with the planned step size. The measurement of radiation level around brachytherapy shows the level is within the criteria.

CONCLUSION: The QA test shows that status of brachytherapy and its components are functioning well. Radiation dose delivered to the cancer patients are within planned dose.

KEY WORDS: air kerma strength, brachytherapy, quality control, radiation protection

INTRODUCTION

Bell in 1903 was first suggested implanting the radioactive source directly into a tumor. Radioactive “seeds” are carefully placed inside of the cancerous tissue and positioned in a manner that will attack the cancer most efficiently1. This Greek word for short distance (brachy) is presently known as "Brachytherapy". Depending on the lesion being treated, brachytherapy can be practiced in following ways: Intracavitary, Interstitial, Surface moulds and Intraluminal. Brachytherapy is used in the treatment of various kinds of cancer, including prostate, breast, cervical, and ocular. Brachytherapy is also used to treat coronary artery disease to prevent restenosis after angioplasty. For a safe and accurate dose delivery using brachytherapy many aspects need to be considered carefully. Furthermore the general safety aspects for the patient, the personnel, and the environment are important issues. In order to ensure the optimal treatment of patients much effort is required during the commissioning phase of new brachytherapy equipment, and afterwards during its clinical lifetime. The institution must therefore develop a proper QA program for sources and equipment. The overall objective of the study is to know the quality of brachytherapy at Om Hospital in the treatment of cancer and investigate the new method for maintaining the best quality. The specific objectives of the studies are to find out the Air Kerma Strength of the source, status of brachytherapy machine, dose delivered, activity of Ir-192 source used in brachytherapy, emergency procedure and radiation level.

Different principles are explored by many scientists and researchers in the world about quality control. It is of extreme importance for the general process of quality assurance that these procedures are well defined and understood by a responsible medical physicist. Unfortunately, till now, in Nepal, there are no radiation protection laws and infrastructures, as well as no radiation regulatory board, to control the use of ionizing...
radiations. Although there are many radiological societies/associations, hospital departments in Nepal, but no research has been carried out on quality control of brachytherapy till now. Recently, Nepal is part of the International Atomic Energy Agency (IAEA) and this will certainly strengthen and speed up the creation of radiation protection infrastructures.

This study may help to Radiation Oncologist, scholar, radiation workers and concerned persons to be aware on the efficiency of the machine and to be aware from radiation by providing test results and suggestions.

**METHODE**

This study was done at the Department of Radiotherapy, Brachytherapy Unit at Om Hospital, Kathmandu, mainly deals with the observation of sweet spots (maximum dose distribution) on different dates by using well chamber (SI HDR 1000) and electrometer (SI CDX 2000). On the basis of the observed sweet spot, Air Kerma Strength of the source is determined. Beside this includes the conformation of step size, radioactivity of the nuclides, safety measures of the machine. A careful radiation survey has been undertaken around the brachytherapy by using well calibrated radiation survey meter (FAG, FH 40F1).

**Limitation:** The value of atmospheric pressure obtained from metro office located at the Tribhuvan International Airport may not coincide with the atmospheric pressure of Om hospital, hence found slight variation.

**RESULT**

**Room design**

In the High Dose Rate (HDR) brachytherapy equipment, it is always best to provide single room accommodation. The layout of room will depend upon local circumstances but it will be necessary to ensure that the room is adequately protected, suitably located, large enough to allow access for patients on beds, enough space for the afterloading equipment and sufficient access for emergencies to be dealt with safely. Also wall thickness, floor, ceiling protection and door protection must meet the IAEA’s recommendation. We found all above mention parameters.

**QA measures of HDR Machine**

Since individual treatment equipment and installation details in the treatment room may differ, the exact method to be used for safety checks has to be adapted to the local situation. The following is a list of functions and/or items were tested.

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Sweet spot test

A well calibrated well type chamber is used to perform a number of regular QC tests. The sweet spot was recorded by using well chamber and electrometer. All the instructions given in the manual were followed. The time exposure is 60 second and biasing voltage is -302V.

Figure 1. Radiation dose at different positions (mm)

Figure 2. Radiation dose at different positions (mm)

Figure 3. Radiation dose at different positions

Figure 4. Comparative radiation dose at different source positions

The sweet position observed at the 10\textsuperscript{th} position in the chamber. The variation of the radiation dose observed at different date is shown in (Fig 4). From the result mentioned above it was found that radiation delivered dose by the source was maximum at 10\textsuperscript{th} position. This means the chambers center is at 10\textsuperscript{th} position.

Calibrated Air Kerma Strength ($S_K$) test

The Calibrated Air Kerma Strength observed at various date was compared with the respective manufacturer’s calibration Air Kerma strength. It was found that the manufacturer’s Air Kerma Strength and current Air Kerma Strength variation is large due to the radioactive decay. The comparative Air Kerma Strength study on the manufacturer’s data and the observed data found that the difference in manufacturer’s AKS with Observed AKS on date 7\textsuperscript{th} July, 13\textsuperscript{th} July and 15\textsuperscript{th} July 2009 was found to be -0.27%, 4.45% and 2.37%. The comparison between manufacturer’s AKS and calibrated AKS on the various dates (Fig: 5).

Figure 5. Comparative study of Air Kerma Strength ($S_K$)
Dwell position test

Dwell position test is used to find out exact position of the source. The standard deviation obtained is 0.05.

Radiation level test

The radiation level was observed on the bottom, back, front and left/right side of the brachytherapy equipment. The observed result on date 8th March 2009, 7th July 2009 and 13th July 2009 (Fig 6).

Radioactivity of the source

The observed radioactive decay and the supplied radioactive decay data by manufacturer’s was observed and standard deviation is observed to be 0.096 (Fig 7). The fall of the graph was because of the decay of the radioactive source (Irridium192) which half life is 74 days.

DISCUSSION

In the High Dose Rate (HDR) brachytherapy equipment, it is always best to provide single room accommodation. The layout of room will depend on thickness of the wall, shielding of door\(^{1,2}\). The reason for the maximum peak to be at 10th position is that the most sensitive part of the well chamber is at the centre of the chamber. The slight decrease of the readings on the 10th position on various dates was due to the decay of Ir-192 source\(^{2}\). Data provided in above table as “action level”, reflect the upper limit in clinical conditions. For an acceptance test the design specifications must be compared. Often the design of the system is such that a much better performance can be obtained under reference conditions, such as positional checks with autoradiography. It is the physicist’s task to inspect the performance history of the system\(^2\). All observations Air Kerma Strength falls within 5% tolerance limit, which is acceptable\(^2\). The Air Kerma Strength of the source in the specified position is as expected. The slight variation of the Air Kerma Strength was due to not exact positioning of the source at 10th position of well chamber or due to the difference of pressure between Om Hospital and Tribhuwan International airport. During the source verification test slight deviation was observed due to the source wire and improper position of the film. The fall of the graph shown in Fig 7 was because of the decay of the radioactive source (Irridium192) which half life is 74 days\(^1\). During survey, slightly high radiation level was found bottom of the head of machine than other positions because source is oriented on the bottom of the head. All observed radiation levels are within the safe limit as recommended by International Commission for Radiological Protection\(^13\).

CONCLUSION

Brachytherapy among other radiation therapy for the treatment of cancer diseases is proving itself as a frontline therapy process. Attempts were made observing different parameters to find whether the Brachytherapy installed at Om Hospital & Research Centre is within the standard quality or not. Different experiments were conducted to find Air Kerma Strength, confirmation of step size; related procedures were followed for the quality assurance (QA) and safety measure check of the machine. Beside this, for the radiation safety of working personnel, patients and attendants of the hospital, survey of radiation level has been undertaken and found within the limit as described by ICRP. The calibrated Air Kerma strength on three different dates showed that the values were similar to manufacturer’s calibrated Air Kerma strength and hence prescribed dose distribution on...
specified area or volume of tissue of the patient was as planned. The step size is almost same as we planned. Safety measures and quality assurance tests proved that the status of machine is in good working condition and functioning well. The calculated radioactivity data matched with the manufacturers supplied radioactive data. This deviation observed is due to the source wire and improper position of the film.

REFERENCES