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Research Article

# Positional Consistency of Radiation Isocenter of a Single Energy Medical Linear Accelerator after Use of Fourteen Years for Cancer Treatment

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**Abstract**

The position of radiation isocenter is an important part in quality assurance checks of a medical linear accelerator (Linac). All radiotherapy treatment planning's and their delivery are done by taking radiation isocenter as a reference point. This isocenter can shift when the gantry, collimator and patient couch do not move symmetrically with each other. In our study, the radiation isocenter verification was done by using a special therapeutic film with digital image processing by using special software. Image acquisition was done using scanning of radiation exposed film by 6 MV photon beam with star shot method. This star shaped beam was designed by the rotation of the collimator, gantry and couch individually. The consistency of position of radiation isocenter was checked five times within last one year randomly by rotation of gantry, collimator to the couch of the medical Linac which is being used since fourteen years for cancer treatment. The mean value throughout the year shows that the size (diameter) for rotational gantry is 0.46 mm, collimator is 0.42 mm and 0.48 mm for the couch. As per AAPM report 40, the size of the Linac radiation isocenter diameter used in this study is still in good agreement because the value of the radiation isocenter is less than 2 mm diameter.

## INTRODUCTION

Modern radiation therapy is one crucial method for cancer treatment and it is commonly used throughout the world now [1]. One of the modalities of modern radiotherapy used for the treatment of cancer is a Linear Accelerator (Linac). This Linac produces electron beam and X-rays (photons) generated by the generator and have the energy that can be varied [2]. Aggressive Quality Assurance (QA) tests play a very important role in ensuring that the treatment given to patients has been correctly conducted. Modern radiotherapy treatment techniques such as Three-Dimensional Conformal Radiotherapy (3DCRT), Intensity Modulated Radiation Therapy (IMRT), Image Guided Radiotherapy (IGRT) and Stereotactic Radiosurgery (SRS) aim to deliver maximum radiation dose to the cancer cells and the minimum radiation dose to the surrounding critical structures and normal tissues. Therefore, various QA tests should be conducted on Linear Accelerator for ensuring accurate dose delivery [3]. The response of radiotherapy depends on various factors, one of them being the accuracy of the location of irradiation on the planning to the implementation of performed irradiation. Verification of radiation isocenter has a very important role on the quality of radiation therapy delivered [4]. Radiation isocenter is a very fundamental part of commissioning and QA testing because isocenter of linac locates the area of irradiation in radiotherapy [5]. Basically isocenter is an imaginary point which is at 100 cm distance from the target of medical linac placed along central axis of beam. The axes of rotations of gantry, collimator and couch meet at this point which is called as isocenter. Verification of isocenter radiation aims to determine Linac beam diameter and it should be checked periodically.

In the radiotherapy treatment, equipment used should be very accurate. The proper position of isocenter mostly uses positional mechanism of collimator, gantry, and couch that aim to optimize the target range and minimize exposure of surrounding healthy tissues [6]. As per Task Group 40 American Association of Physicists in Medicine (AAPM), verification of radiation isocenter is conducted periodically [7]. Also recommendation provides tolerance limit of radiation isocenter to be 2 mm, because the

radiation isocenter can be shifted during the gantry, collimator and couch rotation [8]. Therefore it is necessary to verify the radiation isocenter on the X-ray beam plane of 6 MV linear accelerator using therapeutic film with digital imaging process.

## MATERIALS AND METHODS

In our study we used a Primus Linac (Siemens) having single energy which is available in our Centre and it is used since fourteen years for cancer treatment. Now-days around 40 patients are treated daily by this linac. Kodak $EDR_2$ therapeutic films were used to expose the radiation with star patterns by rotation of gantry, collimator and couch. In star patterns we used angles $0^0$, $30^0$, $60^0$, $90^0$, $120^0$ and $150^0$ for collimator, gantry and couch. Then the exposed films were processed manually in dark room. For scanning of processing films we used EPSON perfection V700 scanner for digital images. A software (PTW, ISOCHECK 1.1) was used for calculation and positional. Isocenter is very important in radiotherapy treatment using a Linac. Isocenter QA in radiotherapy Linac is a star shot method [5]. For the radiation isocenter star shot method is shown in Figure 1.

A stellar beam shot is obtained by placing the film in the field of radiation by rotational motion of a gantry, collimator and a couch. Film will be exposed to radiation from different angles of rotation so that the beams intersect to form stars. Radiation isocenter verification is done by determining the smallest circle of the intersection of all the fields, with the center of the circle called radiation isocenter and the radius of the circle called the size of the radiation isocenter. To determine shifts radiation isocenter can be seen from the result of the diameter of the beam intersecting circle of irradiation [6]. The positional consistency of radiation isocenter was checked five times within last one year with the gap every 2-3 months by rotation of Gantry, collimator and the couch of the medical Linac in our centre. As per AAPM report 40, the size of the Linac radiation isocenter diameter should not be more than 2 mm diameter.

## RESULTS AND DISCUSSION

Positional consistency of radiation isocenter has been performed by using star shot image where the radiation beam shaped like a star due to the rotation of one of the Linac component, the gantry, the collimator and the couch individually. To determine the diameter of the radiation isocenter, image processing was done by using PTW isocheck 1.1 software. The physical visualization of radiation isocenter of collimator, gantry and couch are shown in Figure 2 after processing by the software.

Positional determination of radiation isocenter diameter on Linac is very important and will have an impact on the quality of radiation therapy given to patients. For accurate radiotherapy treatment delivery, gantry, collimator, and couch positions combined are checked properly during QA of Linac. If the positional accuracy of radiation isocenter is within the specified limit then it is clear that the positional accuracies of gantry, collimator, and couch are also within permissible limit. The results of verification of radiation isocenter are shown in Table 1 for all five experiments. As per result the maximum diameter length of isocenter for collimator rotation angles obtained is 0.6mm and mean value is 0.42mm with standard deviation of 0.11. Similarly for gantry rotation angles obtained is 0.6mm and mean value is 0.46mm with stand deviation of 0.10. It has also been found that for couch rotation angles the maximum diameter of isocenter is 0.70mm and mean is 0.48 mm with standard deviation of 0.14. Our results are very much similar with the results which were reported by Muhammad Irsal et al, [10]. The shape of radiation isocenter diameter causes enlargement of penumbra or increases radiation dose on irradiation field shape, especially for small field treatments. This can happen because of asymmetry and instability of the tools used. Based on the use of Linac for radiotherapy irradiation, collimator often used for irradiation method on every patient is different. The positional consistency of radiation isocenter is in very good agreement as the standard deviation values of all three cases are very small. This means the positional inaccuracy of isocenter is very very

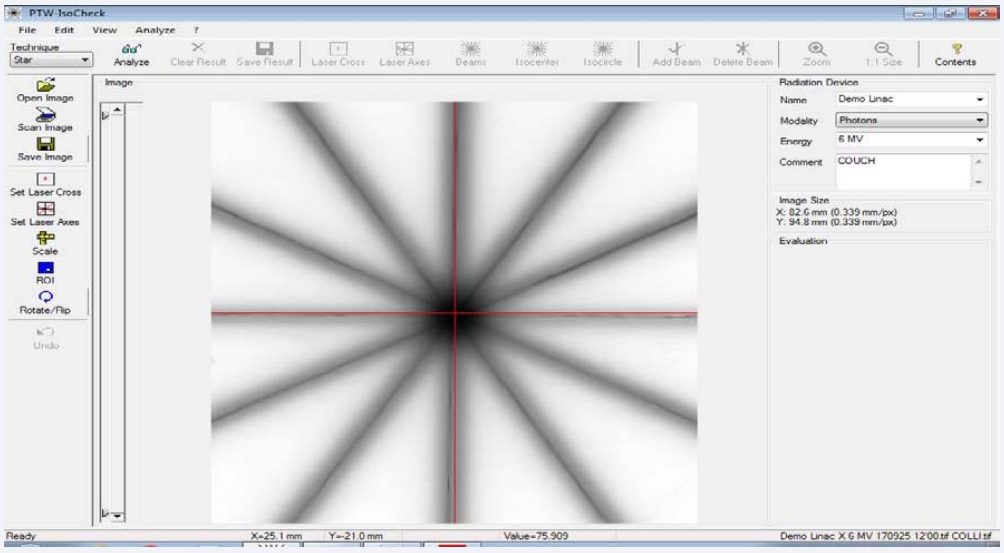


**Figure 1** Radiation isocenter star shot method obtained by our linac.

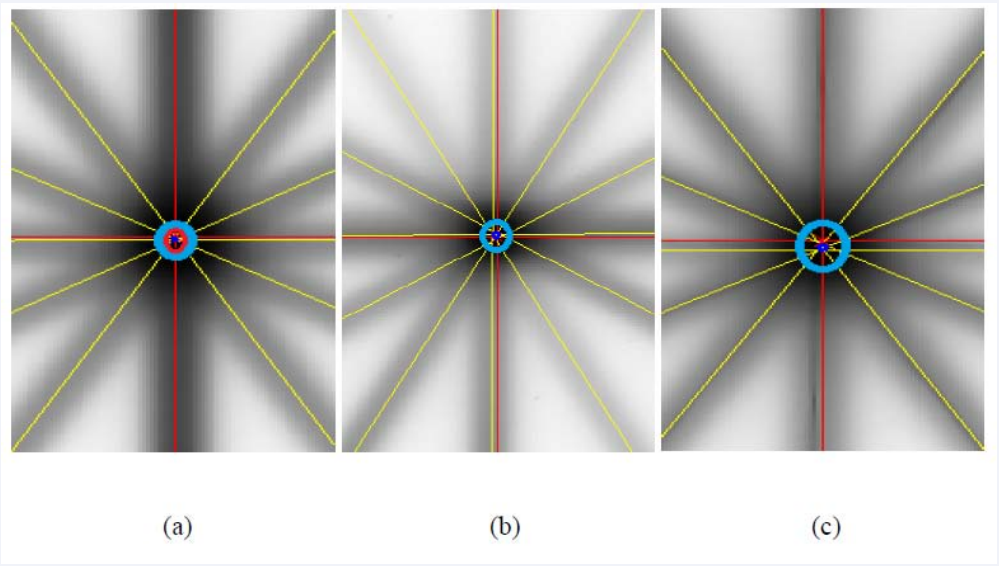


**Figure 2** Physical visualization of radiation isocenter after processing by software of (a) Collimator, (b) Gantry & (c) Couch in one day test.

less and it is well within the limit prescribed by AAPM report 40. The size of the Linac radiation isocenter diameter used in this study is still in good agreement because the value of the radiation isocenter is less than 2 mm diameter.

## CONCLUSION

In view of our experimental data the verification of radiation isocenter performed on collimator, gantry and the couch, it shows that the size of radiation isocenter diameter for collimator is 0.42 mm, for gantry 0.46mm and 0.48 mm for the couch. On the basis of AAPM report 40, our result is extremely good and it is well within the permissible limit as our Linac is very old and we are using this since fourteen years for cancer treatment in our centre.

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## REFERENCES

1. Choirul A. Monte Carlo Simulation for Electron Contamination On Linac Beam 6 MV Aircraft Production Elekta SL15 Thesis Mathematic and Natural Science Medical Physics of Post Graduate Programme (Jakarta: University of Indonesia). 2011.
2. Deinar F. Dose Distribution to Asymmetry Field 6 MV X-rays with Depth Variation Thesis Mathematic and Natural Science Medical Physics of Post Graduate Programme (Jakarta: University of Indonesia). 2010.
3. Peace T, Subramanian B, and Ravindran P. An Experimental Study on Using a Diagnostic Computed Radiography System as a Quality Assurance Tool in Radiotherapy Australasian Physical and Engineerig. Sci Med. 2008; 313: 216-234.
4. Yin Z, Kai D, Garth C, Erik T, Elwood A, Ken KW. Alignment of Multiradiation Isocenter for Megavoltage Photon Beam. J Applied Clin Med Physics. 2015; 166: 314-324.
5. Gonzalez A, Castro I, and Martinez AJ. A Procedure to Determine the Radiation Size in a Linear Accelerator. Med Phys. 2004; 316: 1489-1493.
6. Depuydt T, Penne R, Verelle D, Hrbacek J, Lang S, Leysen K, et al. Computer-Aided Analysis of Star Shot Films for High-Accuracy Radiation Therapy Treatment Unit IOB Publishing. Phys Med Biol. 2012; 57: 2997-3011.
7. Gerald J K, Lawrence C, Michael G, William F H, Steven L, Robert J M, et al. Comprehensive QA For Radioation Oncology: Report of Taskgroup 40. Med Phys. 1994; 21: 581-618.
8. Weiliang D, Jennifer LJ, Wei J, dan Rajat JK. On the Selection of Gantry and Collimator Angles for Isocenter Localization Using Winston-Lutz Tests. J Appl Clin Med Phys. 2016; 17: 167-178.
9. Muhammad Irsal. Verification of Radiation Isocenter on Linac Beam 6 MV using Computed Radiography. J Phys. Conf Ser. 2017.

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