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DOSIMETRIC STABILITY PERFORMANCE OF HALCYON COMPACT LINEAR ACCELERATOR INSTALLED FIRST TIME IN EASTERN INDIA

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ABSTRACT

Background: Halcyon has an enclosed, ring-mounted gantry and a 6 MV flattening filter free (FFF) beam. This beam is used for both treatment and imaging for Halcyon version B. **Methods:** The dosimetric stability performance of the Varian HALCYON has been studied 6 times in one year since its installation. All dosimetric data obtained by own Halcyon software by Machine performance check (MPC) method. **Results:** The average value of all six sets of dosimetric data show well agreement within manufacture's Thresholds. Which means Halcyon can deliver accurate and precise radiation to particular target area as per requirement. **Conclusion:** Our study concludes that Halcyon is a good compact linear accelerator which can be easily used for modern radiotherapy treatment and patient imaging purposes.

KEYWORDS: MPC, Halcyon, Dosimetry.

INTRODUCTION

Halcyon is a compact Linear accelerator designed by Varian Medical System. The main features of this new treatment device are given in Table I. It has an enclosed, ring-mounted gantry and a 6 MV flattening filter free (FFF) beam. This beam is used for both treatment and imaging for Halcyon version B, installed in our centre first time in eastern india in March-2020. Because the gantry is enclosed, it is allowed to rotate significantly faster than conventional C-arm treatment devices – with a maximum rotation speed of 360° in 15 s. The Halcyon B linac only permits the delivery of dynamic multi-leaf collimator (MLC) plans in clinical mode (field-in-field, IMRT, or RapidArc), and has a dual-layered, stacked MLC that projects to a maximum field size of 28 X28 cm^2 at isocenter. Each leaf is 1 cm wide with 58 upper and 56 lower MLCs for a total of 114 leaves. The top layer is displaced by 0.5 cm laterally relative to the lower layer **(1)** to reduce linter-leaf leakage. The leaves have a maximum speed of 5.0 cm/s, twice that of current Varian MLCs. There are no moving collimating jaws because the dual-stack MLC design is designed to provide adequate shielding and allows for "per-leaf tracking" as opposed to the jaw tracking feature in other C-arm linacs.

Table No. 01: Features of the Halcyon Linear accelerator (with Eclipse treatment planning system).

Halcyon Feature	Description
Beam model	Pre-defined
Ring mounted gantry	15 Sec rotation time
Enclosed gantry bore	100 cm diameter
Treatment and imaging beam	6 MV FFF
Nominal dose rate	400 MU/min
Dual layer, stacked MLC design	Dynamic MLC, 5 cm/s leaf speed
Maximum field size	28 x 28 cm2
Varian IGRT Couch	Coplanar with mounted camera
Alignment at isocenter	IGRT only, no light field, no ODI

If we think about typical workflow on the Halcyon, the patient is first positioned using lasers outside of the Halcyon gantry housing. The couch is then translated into the bore by a specific distance, moving the patient to

the treatment position. MV images are then acquired to verify that the patient is accurately positioned for treatment. As there is neither light field, optical-distance-indicator, nor mechanical distance measurement device, accurate patient set-up relies largely on MV imaging. In-line of the radiation source, on the opposite side of the gantry is an electronic portal imaging device (EPID) positioned in front of a beam stopper. In the version that we tested (HALCYON B), all treatments were image-guided, using either MV orthogonal projections. For each image method, there is a choice of "low-dose" or "high-quality" mode. Since, the dose from this imaging beam is included in the treatment plan, the choice of the imaging technique must be made before treatment planning commences.

MATERIALS AND METHODS

Daily quality assurance (QA) of medical linear accelerator is a standard practice in radiotherapy clinics. These QA tests include checks of x-ray output, energy, and beam profile constancy as well as image-guided radiation therapy (IGRT) functionality as recommended by the American Association of Physicist in Medicine (AAPM) Task Group (TG) 142 **(2)** MPPG5a **(3)** and TG-179 **(4,5,**6) In general, several devices are used each morning to perform this QA.

Varian Medical Systems (Palo Alto, CA, USA) recently released the Machine Performance Check (MPC) system, which is a fully integrated self-check tool for assessing the performance of the linac. Machine Performance Check (MPC) is an automated set of quality assurance (QA) tests that use a phantom placed on the couch and the linac's imaging system(s) to verify the beam constancy and mechanical performance of the Halcyon linac.

MPC uses a vendor-supplied phantom which is placed on the couch at the H2 position in case of halcyon, using either a separate bracket or a bracket that is already attached to the phantom (depending on the system). Images of the phantom are acquired with various combinations of collimator positions, gantry angles, and couch positions through an automated sequence. Beam performance checks include beam output constancy, beam uniformity, and beam center shift. Geometry checks include the radiation isocenter size and a measure of coincidence with MV and kV imaging isocenters, as well as checking collimator and gantry readout accuracy, MLC and jaw positioning, and couch positioning accuracy. The MPC tests are executed as a special mode on the linac. All motions (gantry, collimator, and couch) are automatic, as is the analysis of the images. The MPC results are then presented relative to a baseline for the beam performance checks, and compared to absolute specifications for the geometric tests.

- The Halycon has a "virtual isocenter" where the patient (phantom) is setup outside of the treatment bore, and then moved to the true isocenter by couch motion. This movement is checked by the MPC for the Halcyon.
- The Halcyon does not allow couch rotations.
- The MPC is part of a built in safety mechanism on the Halycon. On these, unit beams cannot be run in clinical mode unless the MPC has been run and passed on to that calendar day.

The Six sets of MPC data collected within one year in two months one set in our institute by our Halcyon Linac and its average data set is presented in table no. 02.

Table No. 02: 6X FFF-Beam & Geometry Check (MV), Average data set, (Base line: March19, 2020, 6.30 PM).

Checking Parameters	MPC readings average data	Thresholds value
	Value	
Isocentre		
size	± 0.66 mm	± 0.90 mm
MV imager projections	± 0.17 mm	± 0.50 mm
Beam		
Output change	+ 0.55 %	± 4.00 %
Uniformity Change	+ 0.28 %	± 2.00 %
MU1 Gain Change	+ 0.00 %	± 10.00 %
MU2 Gain Change	+ 0.00 %	± 10.00 %
Collimation		
MLC	Pass	Pass
MLC Reproducibility	Pass	Pass
Field Edges		
Offset Y1	+ 0.07 mm	± 1.00 mm
Offset Y2	+ 0.15 mm	± 1.00 mm
Rotation Offset	+ 0.18 ^{0}	± 0.50 ^{0}
Gantry		
Absolute	- 0.05 ^{0}	± 0.50 ^{0}
Relative	+ 0.02 ^{0}	± 0.50 ^{0}
Couch		

Lateral	+0.02 mm	± 0.50 mm
Longitudinal	0.00 mm	± 0.50 mm
Vertical	+ 0.24 mm	± 0.50 mm
Lateral (Long)	+ 0.47 mm	± 1.00 mm
Longitudinal (Long)	-0.08mm	± 1.00 mm
Vertical (Long)	+ 0.59 mm	± 1.00 mm
Virtual- to – isocentre Lateral	-0.90 mm	± 2.00 mm
Virtual- to – isocentre Longitudinal	-0.07 mm	± 2.00 mm

RESULTS

To evaluate the reproducibility of the MPC tests and also halcyon dosimetric stability performance, we have taken the six sets of MPC data collected within one year in two months one set of data in our institute by our Halcyon Linac and its average data set presented in table no.02. All six checking parameters like isocentre, beam, collimation, field edges, gantry and couch are within thresholds value. This result indicates halcyon dosimetric performance is very good and good agreement within the limiting thresholds or base line value.

CONCLUSION

It can be suggested that the MPC can be used for daily basis QA in halcyon setup. Our study concludes that Halcyon is a good compact linear accelerator which can be easily use for modern radiotherapy treatment and patient imaging process.

Conflict of Interest: Nil.

REFERENCES

1. Thompson S, Constantin M, Kokkonen P. Eclipse Photon Beam Models for Halcyon. Varian Medical Systems: Technical Perspectives, 2017.
2. Klein EE, Hanley J, Bayouth J, et al. Task Group 142 Report: quality assurance of medical accelerators. Med Phys., 2009; 36: 4197–4212.
3. Smilowitz JB, Das IJ, Freygelman V, et al. AAPM medical physics practice guideline 5.a: commissioning and QA of treatment planning dose calculations – megavoltage photon and electron beams. J Appl Clin Med Phys., 2015; 16: 14–34.
4. Bissonnette J-P, Balter PA, Dong L, et al. Quality assurance for image-guided radiation therapy utilizing CT-based technoogies: a report of the AAPM TG-179. Med Phy., 2012; 39: 1946–1963.
5. Smith K, Balter P, Duhon J, et al. Medical physics practice guideline 8.a.: linear accelerator performance tests. J Appl Clin Med Phys., 2017; 18: 23–39.
6. Smilowitz JB, Das IJ, Feygelman V, et al. Medical physics practice guideline 5.a.: commissioning and QA of treatment planning dose calculations - megavoltage photon and electron beams. J Appl Clin Med Phys, 2015; 16: 14–34.