Comparison of Lens Dose Received During 2.5 MV and 6 MV Imaging

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INTRODUCTION

2.5 MV filter free imaging was introduced on Varian TrueBeam linear accelerators in 2016 and is generated along the same beam path as other photon energies. One advantage of 2.5 MV imaging is that it can result images with increased contrast and resolution compared to 6 MV. However since it is not a flattened beam, the unfiltered soft x-rays result in a significant increase in surface dose. A common application of 2.5 MV imaging is in non-coplanar head and neck treatments such as HyperArc® where increased anatomical definition is useful. However this may result in an increased lens dose when acquiring anterior images of the head with this imaging beam.
This study compares the relative dose received by the lens during 2.5 MV and 6 MV imaging for a 35-fraction head and neck treatment using an anthropomorphic head phantom and Gafchromic film.

AIM

- Perform depth dose measurements to confirm the surface dose and depth of maximum dose.
- Absolute dose calibration of 2.5 MV and 6 MV.
- In-vivo dosimetry using an anthropomorphic phantom and Gafchromic film. Acquiring high quality anterior images to simulate head and neck treatments

METHOD

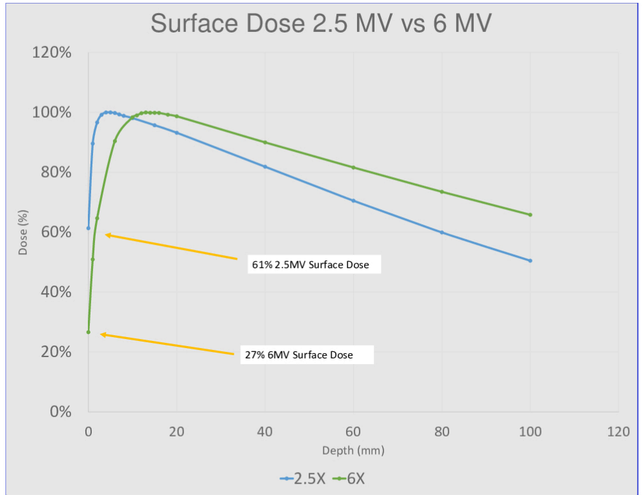
Evaluation of surface dose and depth-maximum for both 2.5 MV and 6 MV was carried out in a RW3 solid water phantom with PTW Advanced Markus chamber at central axis without a buildup cap for 10x10 cm field size at 100 cm SSD,.

Absolute dose calibration was performed, and the machine output was adjusted for both 2.5 MV and 6 MV to deliver 1cGy per monitor unit under TRS-398 reference conditions.

In-vivo dose measurement was carried out on an anatomical head phantom with 3mm of mouldable wax over the top to simulate eyelid and cornea tissue thickness (as per ICRP 103 reporting depth). A 1x1 cm EBT3 Gafchromic film piece was placed under the wax to assess the lens dose and the phantom was aligned to isocentre.

35 high-quality 2.5 MV images were acquired anteriorly at gantry 0 degrees, 30x30 cm field size, repeated twice. This was then repeated twice for 6 MV without moving the phantom. Film was analysed in FilmQAPro software.

RESULTS



Using RW3 solid water and an Advanced Markus parallel plate chamber, the surface dose measured for 2.5 MV and 6 MV was 27% and 61% respectively.

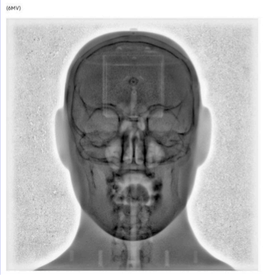
Depth (mm)	2.5 MV		Depth (mm)	6 MV	
	M	Normalised		M	Normalised
0	0.646	61%	0	0.248	27%
1	0.944	90%	1	0.474	51%
2	1.018	97%	2	0.602	65%
3	1.045	99%	6	0.841	90%
4	1.053	100%	10	0.915	98%
5	1.053	100%	11	0.921	99%
6	1.051	100%	12	0.928	100%
7	1.046	99%	13	0.930	100%
8	1.041	99%	14	0.929	100%
10	1.033	98%	15	0.929	100%
15	1.008	96%	16	0.929	100%
20	0.982	93%	18	0.923	99%
40	0.862	82%	20	0.918	99%
60	0.743	71%	40	0.837	90%
80	0.631	60%	60	0.759	82%
100	0.532	50%	80	0.684	73%
Max	1.053		100	0.612	66%

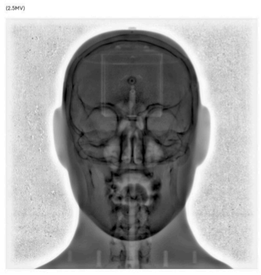
Depth maximum was observed to be 5mm and 14mm for 2.5 MV and 6 MV respectively.

(Left) A CIRS head phantom with EBT3 Gafchromic film placed under 3 mm thickness of mouldable wax.

(Below Left) An acquired 6 MV high-quality image with default window and level settings.

(Below right) An acquired 2.5 MV high quality image with default window and level settings. When the image is enlarged, 2.5 MV images are observed to exhibit less noise and increased details of anatomical structures such as bone when imaging the head and neck area.





	Dose Measurement 1 (cGy)	Dose Measurement 2 (cGy)	Average Dose (cGy)	Relative Difference to 6MV
6 MV	93.6	90.0	92.3	N/A
2.5 MV	130.4	121.6	126.0	+36.5%

(Above) The table show results comparing 2.5 MV and 6 MV imaging dose measured using EBT3 Gafchromic film. A relative dose increase of 36.5% to the lens was observed compared to 6 MV after 35 high-quality anterior images were acquired.

CONCLUSIONS

A percentage depth dose was measured, and absolute dosimetry was performed. The machine output for 2.5 MV and 6 MV was adjusted to deliver 1 cGy per MU under reference conditions as per TRS-398 dosimetry protocol.

An average increase of 36.5% in dose to the lens was measured when 2.5 MV images were acquired anteriorly compared to 6 MV. This is due to the combination of higher surface dose and the lens being situated close to depth maximum of a 2.5 MV beam.

This observation can be used to inform clinicians in the treatment planning process if lens dose is of a concern. Possible methods to reduce the lens dose can be to collimate the jaws during imaging or limiting lens dose in the planning process.

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