

An Analysis of Setup Errors Using OnBoard Imager Technique in External Beam Radiotherapy for Different Cases in Radiation Oncology

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ABSTRACT

Aim: The aim of this study was carried to verify the patient setup errors and immobilization reproducing on the aspects of quality assurance based. The treatment delivers to isocenter on different days and to document efficiency of reproducibility setup errors of treatment.

Materials and Methods: Retrospective study was done out of 80 patients in each cases of radiation treatment such as brain, head and neck, breast and pelvis from this 515 Kv images including CBCTs are taken from the OBI. This Kv images are obtained from OBI system which is attached in linear accelerator. Varian anatomy matching software was used and displacements of three dimensions X, Y and Z were noted to study the patient setup.

Results and Conclusion: This study was shown the probable range of systematic and random errors that occurs in the patient setup during the radiotherapy treatment. In that displacement we calculated mean and average values for different cases such as 4 mm mean deviation for lateral and longitudinal and vertical directions.

Keywords: Onboard imager, Kv images, LINAC, immobilization mask, Varian anatomy software

INTRODUCTION

Successful delivery of conformal fields requires stringent immobilization and treatment verification, as well as knowledge of the setup reproducibility.^[1] Before coming OBI, electronic portal imaging detector was used to detect the setup errors. EPID images are not clear vision to identify correctly and immediately because they were produced by megavoltage X-ray during treatment setup. In OBI images are very easy to identify the errors because they are clear to vision and they are produced by kilovolt age X-rays from OBI system.

In our radiotherapy department this the first review to verify the accuracy and reproducibility of treatment isocenter given to the patients. Our hospital having Varian CLINAC Ix 2300-D it is built with OBI (Onboard imager system). This system gives high resolution, low dose digital imaging system that makes image guided radiotherapy (IGRT) more efficient and convenient. The

OBI tools enable to quickly acquire high quality online images, identify difference in patient positioning and apply corrections before or during treatment. The OBI images are superimposed with reference images which is DRR (Digitally reconstructed radiograph) created by Varian Eclipse TPS (Version 11.0) VARIAN.^[3]

In this study is delivering the radiation dose to the target (tumor) and minimum tolerance dose to the organ at risk (normal tissue). The computed tomography images are transferred to the treatment planning system. These images are contoured and planned for treatment in different technique for different cases during planning, setup fields are created for patient positioning. In that setup field had reference image DRR it will superimposed with OBI images to make a correction in patient positioning setup errors.

For clear verification need quality assurance to obtain good corrections and evaluate the tolerance limits Krishna

Murthy K et al.^[2] The Marker phantom and the cube phantom are used to check the quality images and may helpful to set the patient accurately on isocenter. For that accuracy of patient positioning give the confident to reduce the PTV (planning target volume) margin. The ICRU^[4] [international congress on radiological units and measurements] recommended dose to the target volume should be delivered within +5%.

This study was done with different cases and different techniques such as 2D, 3DCRT, IMRT and Rapid Arc. In that technique IMRT and Rapid arc treatment delivery verified by 2D/2D analysis and CBCT analysis before starting and after treatment for 5 days gap. OBI systems having anatomy matching software tool, 2D/2D, CBCT, fluoroscopic. From this techniques the patient positioning setup errors and the immobilization reproducibility are done easily. Figure 1 shows isocenter shifting OBI image with reference image. Our aim of this study was to compare the three-dimensional distribution of setup variations for patients treated to different regions examples head and neck, brain, breast, and pelvis.

MATERIALS AND METHODS

The study design was retrospective study conducted by department of radiotherapy, CAIMS Cancer Hospital and Research Institute, Karimnagar during the period of January to June 2015.

The setup error study was formulated to isocenter placement errors by comparison OBI images with reference images. The suggested procedure was implemented patient treatment's treated using a high energy linear accelerator CLINAL Ix 2300-D with millennium Multi leaf-collimator (mMLC-120) and OBI images were acquired with an amorphous silicon panel detector. The OBI system has two modes of repositioning which is a radiographic repositioning using best reliable tool for anatomic tools for anatomy registration or radio opaque marker registration and cone-beam CT repositioning.

CT images were transferred to TPS and created plans for different cases and techniques. In that plan setup fields are added for patient setup verification in different angles AP/PA and LL/RL. Obtained images are superimposed with reference images. We measured shifts for all the brain, head and neck, breast and pelvis. Figure 2, 3, 4 and 5 are shows above cases respectively. Since the aim of the study was to determine the patient setup errors i.e., isocenter placement. CBCT repositioning is very similar to the radiographic repositioning technique. The measured shifts are automatically downloaded to the treatment couch of the CLINAC Ix systems simplifying patient repositioning.

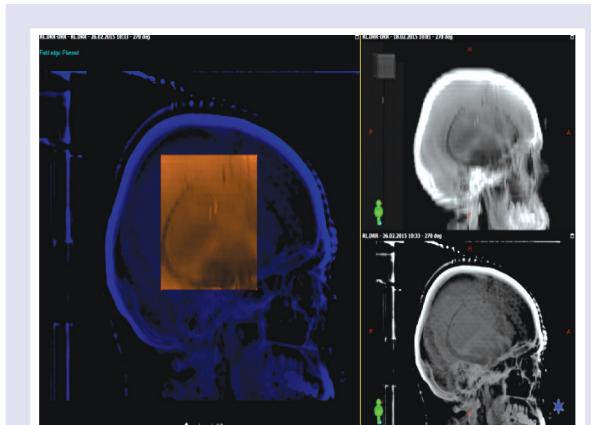


Figure 1: Isocenter shifting

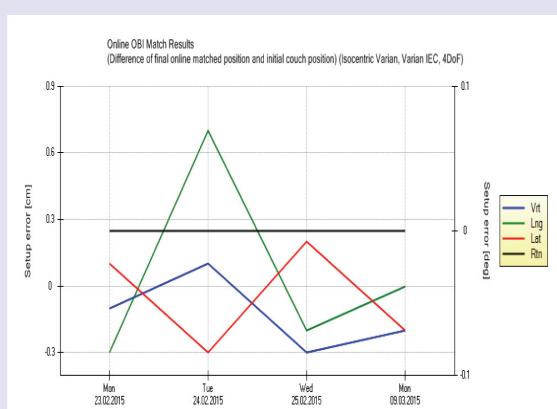


Figure 2: Systematic errors in Brain case

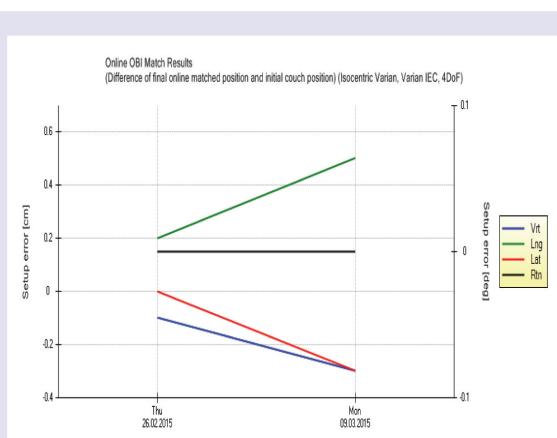


Figure 3: Systematic errors in Head and Neck

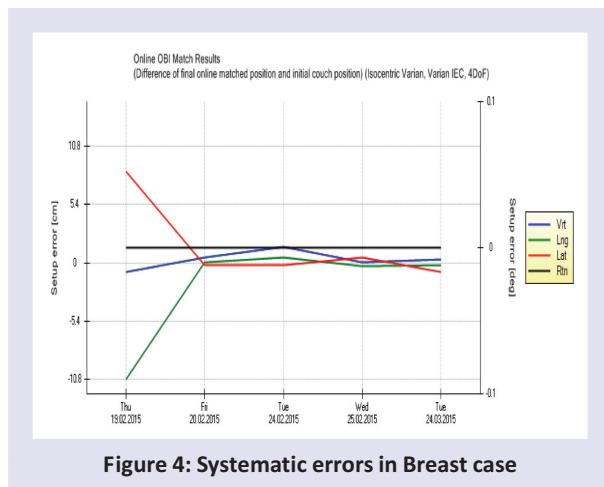


Figure 4: Systematic errors in Breast case

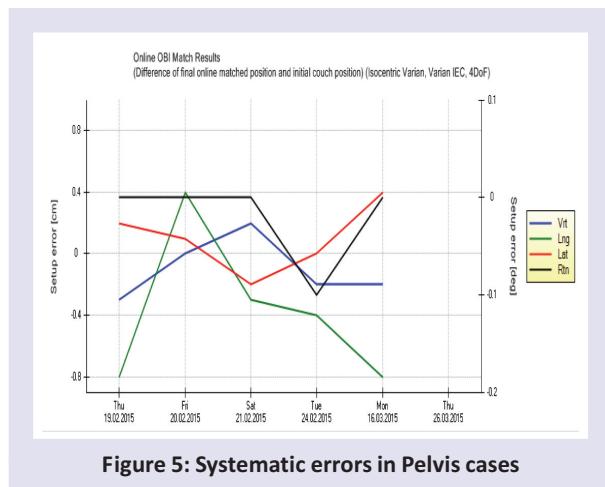


Figure 5: Systematic errors in Pelvis cases

RESULT

The deviations of patient positioning errors recorded from On-board imager systems. And we analysis 515 images of Kv images in 2D/2D and CBCT analyzing methods are used to check the patient setup errors and immobilization reproducibility.

The calculated mean and standard deviation for brain, head and neck, breast and pelvis cases along study details shown in Table1. The average percentage of cases in which mean deviations exceeded 4mm in lateral X, vertical Y and longitudinal Z directions were 5.75%, 5.2%, 6.15% and 12.3% for brain, head and neck, breast and pelvis cases respectively.

during treatment for different diagnosis, in which brain case less possibilities to get errors because cranial region always fixed. It may get errors because of patients uncomfortable only.

The maximum errors occurred in thorax region diagnosis commonly breast cancer. The making of molding for breast cancer is complicated because of anatomy variation in size and structures. In our hospital mostly mastectomy patients were handled. Because of that reason our team discussed before molding which devices and accessories should be use, it is depending on the patient's body structure. These procedures were followed remaining cases like abdomen and pelvis regions.

Table 1: Calculated errors

Site	No. of Patients	No. of OBI Images	% of mean errors in X, Y and Z directions			% of maximum errors in X, Y and Z directions			Average standard errors in X, Y and Z directions		
			Lat(X) mm	Vrt(X) mm	Lng(Z) mm	Lat(X) mm	Vrt(Y) mm	Lng(Z) mm	Lat(X) mm	Vrt(Y) mm	Lng(Z) mm
Brain	20	115	28	18	31	7	4	4	1.6	1.1	1.55
Breast	20	130	32	26	33	8	4	4	1.8	1.2	1.85
Head & Neck	20	128	26	30	29	4	3	3	1.95	1.2	1.15
Pelvis cases	20	142	29	30	30	4	2	3	1.78	1.45	1.3

DISCUSSION

The aspect of this study is set the patients on isocenter. Immobilization devices are important in the treatment position because this device reduces the manual error which was reproducing the same setup on the first day treatment setups. The patient immobilization mask fitness will decreases after 10-15 fractions. For that reason patient weights are noted before treatment execution. Every one week before treatment weights are noted and maintained records. We observed common mistakes in setup errors

The repeated mean deviations less than 4mm in X, Y and Z directions for brain, 5mm for head and neck, 7mm for breast and 7 mm for pelvis. This deviation can also reduce if the patient statted correctly on the couch i.e., reproducing the setup from the time mould. Delineate of CTV and PTV safety margin was calculated from the measurements of setup errors.^[5]

Hurkmans et al^[6] reported in their review article that the setup accuracy varies widely, depending on the treatment site, method of immobilization and institution. The above

study was made a documented database for expressing the accuracy achieved by treatment delivered to the patients.

These results revealed in the present deviations are less than the compared earlier studies.^[7] The OBI images once not in clear to match with reference images means we can take next images instantly this repeated image procedure is not harm compare to EPID images, because that will give unnecessary dose patient while repeating the image procedures.^[8]

In our findings the OBI System reduced the patient setup times, unnecessary dose to patients, finally it gave confidence about treatment i.e conformation of treatment area.

CONCLUSION

Our study has shown that the probable range of systematic and random errors that occurs in the patient setup during the radiotherapy treatment. This work helps us to known the efficiency of immobilization reproducibility method and patient positioning setup with the OBI. On the main thing of it helps to reduce the planning target volume margins and confirmed the accuracy and quality of treatment delivered.

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CONFLICT OF INTEREST

The authors declared no conflict of interest.

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