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Evaluation of the Patients' Setup Accuracy during Radiotherapy Treatment Using Megavolt Electronic Portal Imager Device (EPID)

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Abstract

Purpose: *Setup errors in patient positioning during radiotherapyhave a vital role in the tumor control and overdose of normal tissues. The purpose of this study was to evaluate the setup errors for patients who were treated with different sites using electronic portal imaging device (EPID).*

Methods: *A total of 770 fractions were analyzed from 152 patients; 15 brain, 20 head and neck, 37 left breast, 30 right breast and 50 bladder cases. Setup offsets between reference image and acquired image using EPID werecalculated using MOSAIQ software.*

Results: *The average of 15 brain setup offsets, were calculated with maximum value of 0.5 cm. It's averagevalue was in the range from 0.3 ± 0.2 cm to 0.4 ± 0.1 cm. The average of 20 head and neck setup offsets, the maximum value of 0.5 cm. its average value was in the range from 0.2 ± 0.2 cm to 0.3 ± 0.2 cm. For the average of 37 left breast setup offsets, the maximum was 1.0 cm (the tolerance of breast). the average was in the range from 0.5 ± 0.4 cm to 0.6 ± 0.3 cm. The results of 30 right breast setup offsets, the maximum was 1.0 cm. the average was in the range from 0.5 ± 0.3 cm to 0.5 ± 0.4 cm. For 50 bladder setup offsets, the maximum was 1.0 cm. and the average value was in the range from 0.4 ± 0.3 cm to 0.6 ± 0.2 cm. The minimum offsets values in all studied fractions were 0.0cm.*

Conclusion: *The setup errors were a tumor-site dependent. The use of image verification technique such as (EPID) is an effective tool inpatient-setup verification.*

Keywords: *EPID; Patient setup verification, MOSAIQ.*

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I. Introduction:

Radiotherapy (RT) is one of three main components for therapy of a substantial majority of cancer patients.[1,2]In last decade, there have been major advances in radiotherapy technology. These technological developments were the transition from two dimensional (2D) radiotherapy to the implementation of three dimensional conformal radiotherapy (3D-CRT) followed by applying the intensity modulated radiotherapy (IMRT), image guided radiotherapy (IGRT), adaptive radiotherapy (ART) and four dimensional (4-D) imaging and motion management in radiotherapy.[3-6]These new technologies usually combined with an integrated computerized radiation oncology information system (OIS)to allow the cancer centres to become fully networked.[3]

The accuracy degree to apply these technologies in radiotherapy required more effort than before. Achieving the required accuracy degree and maintain it remain central to the treatment process. To sustain the required accuracy in dose delivery, all steps of the RT process need to be covered by comprehensive quality assurance (QA) program.[7]While the accuracy in radiotherapy is vast, including each step in radiotherapy procedures, here, we will focus in this study on the accuracy of patient setup during the treatment delivery.Reproducible positioning of patients in RT with a high degree of accuracy is very critical. The initial definition of the position of the patient and the ability to reproduce this position on a daily basis is required for the accurate delivery of a treatment course. The optimum patient position and the immobilization method are based on several factors such as the clinical site, the extent of the target volume the location of the organ at risk (OAR), and on the type of treatment.

In radiotherapy procedures, once the treatment plan has been completed and approved, the patient is set up, in the treatment position, on a treatment unit. Every treatment, consistency in the positioning should be conformed before starting the treatment. The verification system of the treatment machine is developed rapidly in last decades. Nowadays, there are several patient setup verification methods are available such as MV portal imager, kilo-voltage imager (kv), and cone beam computed tomography (CBCT) which are using currently as a routine for most of radiotherapy centers. During patient setup, there are several error sources which can produce uncertainty during the treatment. These error sources may result in the incorrect application of treatment and should be detected through this procedure. These error sources such as random and systematic errors in radiotherapy. The main difference between the two errors is that the random errors vary arbitrarily in direction and magnitudewhile the systematic errors tend toward a similar direction and magnitude.[3]These two types of error contain patient movement, internal movement, patient setup error, machine mechanical offsets etc.

Radiotherapy treatment verification usually involves that the comparison of aportal image acquired for the patient prior orduring a treatment fraction with a referenceimage generated by treatment planning system (TPS) prior to the initiation of thetreatment course. This image from TPS is called digitally reconstruction radiography (DRR). Also, the first approved portal imagesometimes is used as the reference image. The two images are acquired from two different image modality where the portal image isformed by the MV beam used to treat the patient,the reference image is formed by kv beam. It is generally accepted that the quality of images acquiredusing MV x-rays is inherently poorer than that acquiredwith kv x-rays. Recently, the manufactures of treatment machines (Linear accelerators "Linacs") added low MV energy for image acquired use not clinical use to improve the image quality. For MV portal image, besides the well-known decreasein subject contrast such as the differential attenuationbetween bone and air, bone and soft tissue, and air and soft tissue, as the energy of anx-ray beam increases, several other factors contribute to thepoor quality of portal images. These factors are the performanceof the image receptor, x-ray scatter due to patient thickness,the size of the x-ray source, noise in the human eye–brainsystem, and the position of the image receptor.[8]

In last decades, the setup verification system is developed rapidly. For a longperiod of time, simulation of the actualradiation therapy by means of fluoroscopyand kv X-ray images acquiredfromthepatientin treatmentpositiondeterminedthe volumeto be treated.[9]Treatment fields were thus typically orientedat bony landmarks, and tumorsas well as healthy tissues were translatedinto these X-ray images that representedthe treatment fields. In this process,information about anatomical relationshipsand information about tumorlocalization retrieved from clinicalexamination and anatomical knowledgewere correlated and taken into account inthe process of defining radiation portals.[9]These radiation portals were thereforehighly standardized and treatment wasoften characterized via "treatment fields."After advent of CT, the RT technology was developed very fast including the setup verification system. It became possible to directly visualizethe tumor and organs to be spared fromradiation. X-ray-based imagingwas taken on-board the treatment unititself, so that in-room image guidancepresently is the standard of practice inradiation oncology.[10,11] More recently,image-guided radiotherapy (IGRT) increasinglyincludes time as a fourthdimension in treatment planning anddelivery, and consequently accounting forany movements during the treatment course of RT.

With this innovation of patient setup verification in RT course, in this study we evaluated the patient setup accuracy using the electronic portal image device (EPID) that is because this is the only setup verification system available in our hospital.

II. Materials And Methods:

2-1 **Materials:**

Treatment machine

Materials employed in this study include Elekta Synergy Platform linear accelerator (linac) equipped with amorphous silicon portal electronic imager device (a-Si EPID) at the clinical oncology and nuclear medicine department, Faculty of medicine, Menoufia University, Egypt. The clinical linac produces photon beams of energies 6 and 10 MV, and electron- energy beams of 4, 9, 12, and 18 MeV.

2-2 **Setup verification imaging device**

The a-Si EPID is mounted on robotic arm at source- to-imager distance (SID) of 160 cm and comprises an image detector unit with an active MV detector area of 41 × 41 cm^2 (approximately 26 × 26 cm^2 at isocentre) and resolution of 1024 × 1024 16-bit pixels. Our version is iViewGT^{TM} Elekta software (version R3.02).

The iViewGT™ provides 2DMV planar images within a fraction of a second, and helps in achieving excellent clearance and superior field of view. Also iViewGT™ automatically applies a set of corrections to all images acquired, including offset and gain correction as well as a bad pixel map correction. In acquiring EPID images in iViewGT™, pixel values are automatically re-normalized before saving the image data to the database.

2-3**Treatment Planning System**

Monaco treatment planning system (TPS) (Elekta AB, Stockholm, Sweden, version 5.11.02) was used to generate the plans. The Monaco TPS combines Monte Carlo dose calculation accuracy with robust optimization tools to provide high-quality radiotherapy treatment plans for 3D-CRT, IMRT,andVMAT techniques. Recent technology advances have allowed for fast calculation speeds, which allow clinicians and patients to benefit from the accuracy of the Monte Carlo algorithm while reducing overall planning time.

2-4 **Radiation Oncology Information System**

The radiation oncology information system used in this study wasMOSAIQ providedby Elekta. MOSAIQ is a complete patient management information system that centralizes radiationoncology, particle therapy and medical oncology patient data into a single user interface,accessible by multi-disciplinary teams across multiple locations.MOSAIQ delivers seamless connectivity to virtually any linac and TPS from any vendor, providing unmatched integration and the freedom and flexibility tochoose the optimal treatment solutions for patients.A global leader in Oncology Information Systems, MOSAIQ provides comprehensive image, dataand workflow management from the single physician practice to the most sophisticated providernetworks, offering a robust and scalable solution.

2-5 **Setup verification imaging software**

The iViewGT fits in seamlessly with the other products from Elekta including MOSAIQ data management system and Monaco TPS. As a standard product on Elekta Synergy® Platform, iViewGT helps provide patient setup verification.

iViewGT can create a high quality image with as little as 1 monitor unit (MU) and is available on screen within a fraction of a second. The high sensitivity solid state detector used by iViewGT™ provides greatly improved image quality. Images can be displayed in a variety of ways for optimum review such as lung and bone inversion. Images can be enlarged, scaled, measured, flipped and rotated for ease of comparison with the reference image. Images can be further enhanced using the CLAHE feature for superior image optimization in difficult anatomical sites. Side by side comparison of reference with the acquired image can be done on- or off-line. After image registration, the patient displacement is automatically displayed and recorded for analysis. Annotation notes may be added to an image and stored with it for future reference. Patient position results can be sent for approval and annotations can be added to approve the registration.

2-6 **Method:**

This study was aquantitative-analytical one and aimed to determine the irradiation set up errors using MOSAIQ and iViewGT software/s in RT. It was based on storing images that resulted from the EPID database. The population in this study were all radiation setup verification on radiotherapy of 152 patients.Patients were subdivided based on the treatment site to 15 brain, 20 head and neck, 37 left breast, 30 right breast, and 50 bladder.The result of radiation set up verification wasthen processed by tabulation.

Our patient setup verification protocol was with first three fractions; we acquire image for daily basis after that one verification image per week for each patient. After creating the treatment plan using Monaco TPS, setup fields were added to the plan. Usually, two setup orthogonal fields are added where one field with gantry angle 0 and the second at gantry angle either 90˚ or 270˚,which of these is the nearest to the target. The reference images (DRRs) were created with the setup fields and the data wasimported to MOSAIQ software. During patient setup, verification image was acquired and saved on the MOSAIQ software. Using the software tools, a comparison between the acquired image and reference image was conducted and the software automatically gave us the shift in the isocenter of the field setup in three CT DICOM coordinates directions; Vertical (Anterior/Posterior), Lateral (Right/Left), Longitudinal (Superior/Inferior), and vector magnitudedirection (see Figure 1 for more illustration).

Part of the setup verification protocol is defining the tolerance of the offset values of the couch (isocenter) from the isocenter of reference image. Our tolerances defined as; 0.5 cm for brain and head and neck, 1.0 cm for breast and bladder. Out of these tolerances, the patient must be setup again.

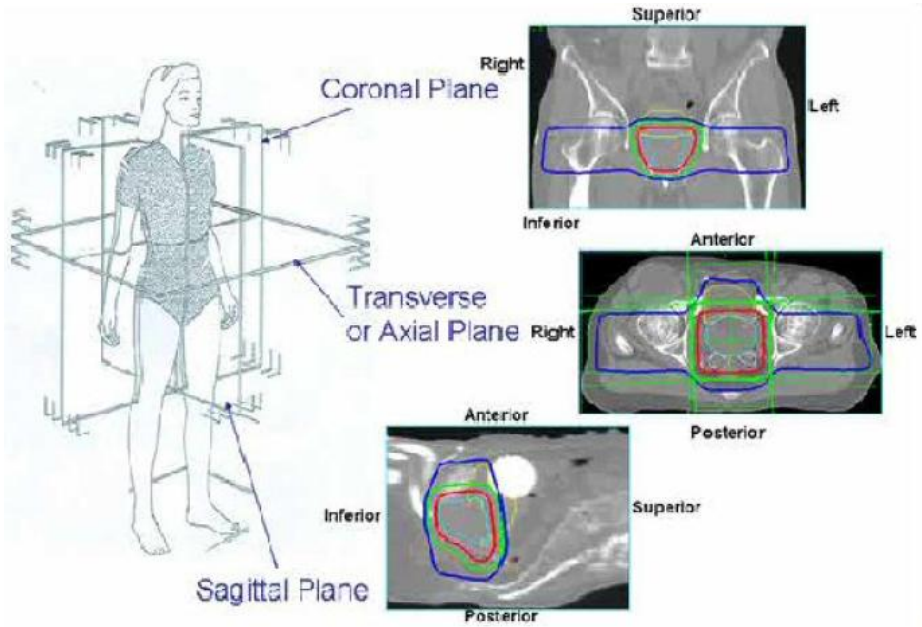

Figure 1: Setup reference image illustration

III. Results:

Site setup verification is mandatory for particle RT treatment delivery, whichestablishes the absolute couch reference for the active treatment session and site. Site setup verification lets us make sure that the correct patient is at the machine withpatient verification. For particle RT, when in a verified mode,MOSAIQ compares actual values to the defined values to make sure that there are no mismatches. The site setup connot completed allmismatches are cleared.MOSAIQ indicates if a parameter is in or out of tolerance.

In this study, setup verification data for 152 patients were used.

Figures 2and3 show examples of offset measurement between the reference image (DRR) and the acquired image by EPID during the treatment of brain patient. Figure 2 shows how the offsets in lateral (Right-left) and longitudinal (Superior-inferior) directions were measured, while figure 3 shows those in case of the vertical (Anterior-posterior) and longitudinal (Superior-inferior) directions.

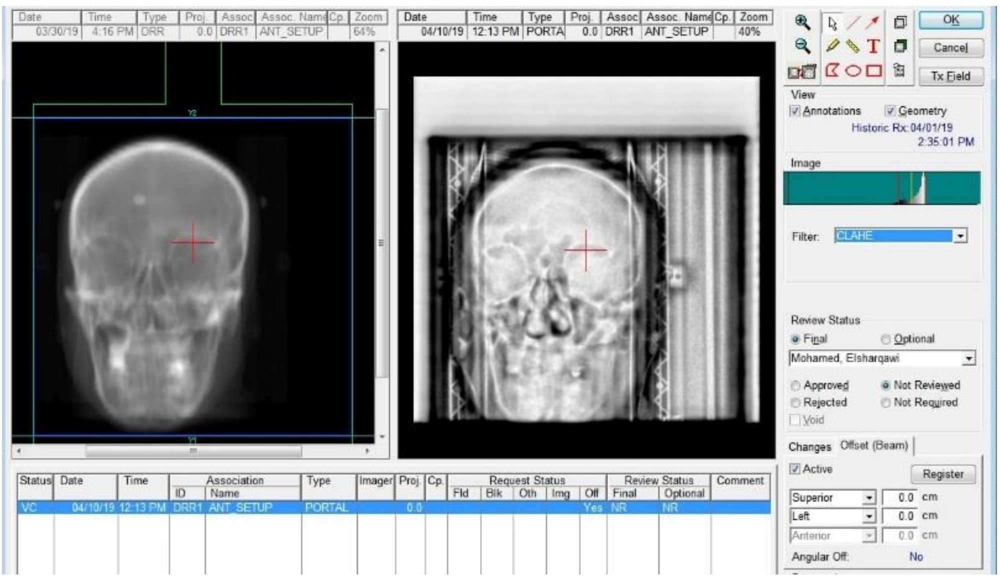

Figure 2: Measurement of the offset of the treatment isocenter than the reference image isocenter inlateral (Right-left) and longitudinal (Superior-inferior) directions.

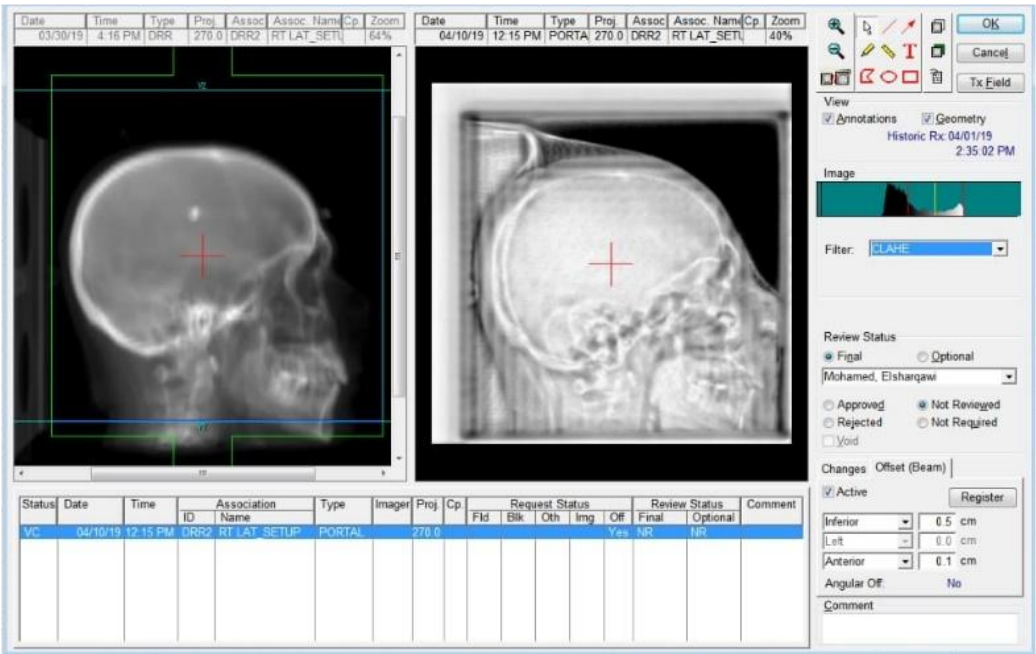

Figure 3: Measurement of the offset of the treatment isocenter than the reference image isocenter in vertical (Anterior-posterior) and longitudinal (Superior-inferior) directions.

Table 1 illustrates the offset between the reference image (represented by DRR) and the setup verification image acquired by EPID during pre-treatment setup for 15 brain patients. The table contains maximum, minimum, and the average offset values of all measurements obtained during the whole treatment course for each patient.

The maximum was 0.5 cm because this is the tolerance for brain. The range of the offset was between 0.0 cm and 0.5 cm. The average was in the range from 0.1 ± 0.1 cm to 0.5 ± 0.1 cm. Also the magnitude of the vector kept to be not more than 0.5 cm which means although the tolerance is 0.5 cm, not allow the three dimensions to be up to 0.5 cm. Table 2 illustrates the offset between the reference image and the setup verification image acquired by EPID during pre-treatment setup for 20 head and neck patients. Same like brain, the tolerance of head and neck is 0.5 cm. The maximum was 0.5 cm and the range of the offset was between 0.0 cm and 0.5 cm. The average was in the range from 0.0 cm to 0.4 ± 0.2 cm.

Table 1: Maximum, minimum, and average values of five setup offset measurements obtained during pre-treatment patient setup for 15 brain patients.

Patient's number	Parameter	Setup offset direction (cm)			
		RT/LT	Sup/Inf	Ant/Post	The vector
1	Maximum	0.5	0.5	0.5	0.5
	Minimum	0.1	0.3	0.3	0.2
	Average	0.3±0.2	0.4±0.1	0.4±0.1	0.3±0.1
2	Maximum	0.5	0.5	0.5	0.5
	Minimum	0.1	0.0	0.0	0.2
	Average	0.3±0.1	0.3±0.2	0.3±0.2	0.3±0.1
3	Maximum	0.5	0.5	0.5	0.5
	Minimum	0.0	0.0	0.0	0.4
	Average	0.4±0.2	0.2±0.2	0.2±0.3	0.5±0.1
4	Maximum	0.5	0.5	0.5	0.3
	Minimum	0.0	0.0	0.0	0.0
	Average	0.3±0.2	0.2±0.3	0.2±0.3	0.2±0.2

5	Maximum	0.5	0.5	0.5	0.5
	Minimum	0.4	0.0	0.0	0.4
	Average	0.4±0.1	0.1±0.1	0.1±0.1	0.5±0.1
6	Maximum	0.5	0.4	0.4	0.5
	Minimum	0.0	0.0	0.0	0.0
	Average	0.3±0.2	0.3±0.2	0.3±0.2	0.4±0.2
7	Maximum	0.3	0.5	0.5	0.5
	Minimum	0.0	0.3	0.3	0.3
	Average	0.1±0.1	0.4±0.1	0.4±0.1	0.4±0.1
8	Maximum	0.5	0.5	0.5	0.5
	Minimum	0.0	0.0	0.0	0.0
	Average	0.3±0.2	0.3±0.2	0.3±0.2	0.2±0.2
9	Maximum	0.4	0.3	0.3	0.5
	Minimum	0.0	0.1	0.1	0.3
	Average	0.2±0.2	0.2±0.1	0.2±0.1	0.4±0.1
10	Maximum	0.3	0.3	0.3	0.5
	Minimum	0.2	0.0	0.0	0.3
	Average	0.3±0.0	0.1±0.1	0.1±0.1	0.4±0.1

Table 1: Continued

Patient's Number	Parameter	Setup offset direction (cm)			
		RT/LT	Sup/Inf	Ant/Post	The vector
11	Maximum	0.4	0.5	0.5	0.5
	Minimum	0.0	0.0	0.0	0.4
	Average	0.2 ± 0.1	0.2 ± 0.1	0.2 ± 0.1	0.4 ± 0.0
12	Maximum	0.5	0.5	0.5	0.3
	Minimum	0.2	0.3	0.3	0.1
	Average	0.3 ± 0.1	0.4 ± 0.1	0.4 ± 0.1	0.2 ± 0.1
13	Maximum	0.5	0.5	0.5	0.5
	Minimum	0.1	0.3	0.3	0.3
	Average	0.4 ± 0.2	0.4 ± 0.1	0.4 ± 0.1	0.4 ± 0.1
14	Maximum	0.4	0.5	0.5	0.5
	Minimum	0.1	0.0	0.0	0.3
	Average	0.3 ± 0.1	0.3 ± 0.3	0.3 ± 0.3	0.4 ± 0.1
15	Maximum	0.5	0.5	0.5	0.5
	Minimum	0.0	0.0	0.0	0.3
	Average	0.3 ± 0.2	0.3 ± 0.2	0.2 ± 0.2	0.4 ± 0.1

Table 2: Maximum, minimum, and average values of five setup offset measurements obtained during pre-treatment patient setup for 20 head and neck patients.

Patient's number	Parameter	Setup offset direction (cm)			
		RT/LT	Sup/Inf	Ant/Post	The vector
1	Maximum	0.2	0.1	0.1	0.5
	Minimum	0.0	0.0	0.0	0.0
	Average	0.1±0.1	0.0±0.0	0.0±0.0	0.2±0.2
2	Maximum	0.5	0.5	0.5	0.5
	Minimum	0.1	0.0	0.0	0.1
	Average	0.2±0.2	0.2±0.3	0.2±0.3	0.3±0.2
3	Maximum	0.3	0.5	0.5	0.5
	Minimum	0.0	0.1	0.1	0.1
	Average	0.1±0.1	0.4±0.2	0.4±0.2	0.4±0.2
4	Maximum	0.4	0.5	0.5	0.5
	Minimum	0.0	0.1	0.1	0.1
	Average	0.1±0.2	0.2±0.2	0.2±0.2	0.3±0.2
5	Maximum	0.5	0.5	0.5	0.5
	Minimum	0.1	0.0	0.0	0.1
	Average	0.2±0.2	0.2±0.2	0.2±0.2	0.3±0.2
6	Maximum	0.5	0.5	0.5	0.5
	Minimum	0.1	0.0	0.0	0.1
	Average	0.4±0.2	0.1±0.2	0.1±0.2	0.4±0.2
7	Maximum	0.5	0.3	0.3	0.5
	Minimum	0.1	0.1	0.1	0.0
	Average	0.3±0.2	0.2±0.1	0.2±0.1	0.3±0.2
8	Maximum	0.5	0.5	0.5	0.5
	Minimum	0.0	0.0	0.0	0.0
	Average	0.1±0.2	0.3±0.2	0.3±0.2	0.3±0.2
9	Maximum	0.5	0.5	0.5	0.5
	Minimum	0.0	0.0	0.0	0.1
	Average	0.1±0.2	0.3±0.2	0.3±0.2	0.4±0.2
10	Maximum	0.5	0.5	0.5	0.5
	Minimum	0.0	0.0	0.0	0.1
	Average	0.1±0.2	0.2±0.2	0.2±0.2	0.4±0.2
11	Maximum	0.4	0.5	0.5	0.5
	Minimum	0.0	0.0	0.0	0.3
	Average	0.2±0.2	0.3±0.2	0.3±0.2	0.4±0.1

Table 2: Continued

Patient's number	Parameter	Setup offset direction (cm)			
		RT/LT	Sup/Inf	Ant/Post	The vector
12	Maximum	0.5	0.3	0.3	0.5
	Minimum	0.0	0.0	0.0	0.1

	Average	0.3±0.2	0.1±0.1	0.1±0.1	0.3±0.2
13	Maximum	0.5	0.5	0.5	0.5
	Minimum	0.1	0.0	0.0	0.1
	Average	0.2±0.2	0.2±0.2	0.2±0.2	0.4±0.2
14	Maximum	0.5	0.5	0.5	0.5
	Minimum	0.0	0.0	0.0	0.1
	Average	0.2±0.2	0.3±0.2	0.3±0.2	0.4±0.2
15	Maximum	0.5	0.5	0.5	0.4
	Minimum	0.0	0.0	0.0	0.2
	Average	0.3±0.2	0.2±0.2	0.2±0.2	0.3±0.2
16	Maximum	0.5	0.5	0.5	0.5
	Minimum	0.0	0.0	0.0	0.1
	Average	0.2±0.2	0.3±0.2	0.3±0.2	0.4±0.1
17	Maximum	0.5	0.5	0.5	0.5
	Minimum	0.0	0.0	0.0	0.1
	Average	0.1±0.2	0.3±0.2	0.3±0.2	0.3±0.1
18	Maximum	0.5	0.5	0.5	0.5
	Minimum	0.0	0.0	0.0	0.1
	Average	0.2±0.2	0.2±0.2	0.2±0.2	0.3±0.2
19	Maximum	0.5	0.5	0.5	0.4
	Minimum	0.1	0.0	0.0	0.1
	Average	0.3±0.2	0.2±0.2	0.2±0.2	0.3±0.2
20	Maximum	0.5	0.5	0.5	0.4
	Minimum	0.0	0.0	0.0	0.0
	Average	0.3±0.2	0.3±0.2	0.3±0.2	0.1±0.2

Table 3 summarizes the mean values of the average of maximum, minimum, and the average of 15 brain patient, 20 head and neck, 37 left breast, 30 right breast, and 50 bladder. For the average of 15 brain setup offset, the maximum was 0.5 cm. The minimum was 0.0 cm and the average was in the range from 0.3 ± 0.2 cm to 0.4 ± 0.1 cm. For the average of 20 head and neck setup offset, the maximum was 0.5 cm. The minimum was 0.0 cm and the average was in the range from 0.2 ± 0.2 cm to 0.3 ± 0.2 cm. For the average of 37 left breast setup offset, the maximum was 1.0 cm (the tolerance of breast). The minimum was 0.0 cm and the average was in the range from 0.5 ± 0.4 cm to 0.6 ± 0.3 cm. The results of 30 right breast setup offset, the maximum was 1.0 cm. The minimum was 0.0 cm and the average was in the range from 0.5 ± 0.3 cm to 0.5 ± 0.4 cm. And for 50 bladder setup offset, the maximum was 1.0 cm. The minimum was 0.0 cm and the average was in the range from 0.4 ± 0.3 cm to 0.6 ± 0.2 cm.

Table 3: The summary of the mean values of maximum, minimum, and average of setup offset measurements for 152 patients.

Case of study	No. of Patients	Parameter	Setup offset direction (cm)			
			RT/LT	Sup/Inf	Ant/Post	vector
BRAIN	15	Maximum	0.5	0.5	0.5	0.5
		Minimum	0.0	0.0	0.0	0.0
		Average	0.3±0.2	0.3±0.2	0.3±0.2	0.4±0.1
HEAD AND	20	Maximum	0.5	0.5	0.5	0.5

NECK		Minimum	0.0	0.0	0.0	0.0
		Average	0.2±0.2	0.2±0.2	0.2±0.2	0.3±0.2
LEFT BREAST	37	Maximum	1.0	1.0	1.0	1.0
		Minimum	0.0	0.0	0.0	0.0
		Average	0.5±0.4	0.6±0.3	0.6±0.3	0.6±0.3
RIGHT BREAST	30	Maximum	1.0	1.0	1.0	1.0
		Minimum	0.0	0.0	0.0	0.0
		Average	0.5±0.3	0.5±0.3	0.5±0.3	0.5±0.4
BLADDER	50	Maximum	1.0	1.0	1.0	1.0
		Minimum	0.0	0.0	0.0	0.1
		Average	0.4±0.3	0.5±0.3	0.5±0.3	0.6±0.2

IV. Discussion

As variations in day-to-day patient positioning in RT may cause under- or overdosage to the patient, the verification of daily patient positioning is an indispensable aspect of RT quality control.[12]RT verification is the process which enables that volume of interest is treating as it is planned. In this process, the geometrical localization can be done acquiring a control image of the patient in the treatment position and its matching with digitally reconstructed radiograph (DRR) obtained with the TPS.

EPID was the first on-board image device used for patient positioning verification and still in use in most of radiation oncology centers. Although, the main disadvantage of EPID is the poor of image quality comparing with the most advanced other IGRT modalities, it has many advantages where it is compact, easy for setup, and fast for use. It also characterizes by gives immediate results.

EPID is the only IGRT device available in our hospital (Menoufia university hospital), then we had to give more effort to get correct patient position. The poor of the image quality mandated us to get sometimes more than one image exposure to the same position to be sure from the anatomy contrast. Also it requires qualified staff either from radiation oncologists or radiotherapists to have professionally to identify the correct matching of the acquired patient setup verification image with reference image. Leak of this professionally makes this verification procedure hard where it will be time consuming and increases the potential of patient movement. Although the limitation of the EPID, we did our best to get acceptable patient setup errors comparable with the international protocols.[13]

From the results we got in this study, the EPID device, with all its limitations, still an effective tool for patient setup verification. We created our patient setup tolerance protocols guided by the international protocols, also taking in consideration the nature of the treatment site. For sites such as brain and head and neck, because these suites are rigid where the tissues in these area not in movement, we designed the tolerance of the deviation to apply the shift to be 0.5 cm. On the contrary, sites like breast and bladder, the tissues in continuous movement as in breast area because the patient breathing or continuous changes in the treatment volume in bladder because the filling level of urine inside the bladder, we designed the tolerance to be 1.0 cm.

By analyzing 770 setup verification images for 152 patients, the results and its statistics show that the setup errors depend on the tumor site and the use of image verification technique (EPID) is an effective tool for patient setup verification.During our study and our routine work, some patients with special situation such as obesity or leak of anatomical contract of the treatment area, there was difficulty to get the correct treatment position of the patient and the division between the isocenter of the acquired verification image and corresponding isocenter of reference image was outside the tolerance. For that, although the results of this study are satisfied to conduct the patient position verification during RT treatment, we recommend to upgrade our RT treatment system to add one or more additional IGRT image modality with high image quality to facilitate the image verification process of patients with special situation and also to be as a backup incase the EPID is dysfunction.

V. Conclusion:

Acquiring patient position verification images during radiotherapy treatment becomes as a routine work with all patients using different image modalities. With new image modalities such as Megavolt imagers, Kilovolt imagers and cone-beam computed tomography (CBCT), the image verification become easy to acquired and analyzed. With this new technology in the on-board imagers with multimodalities, the verification images process converted from off-line to be on-line where the deviation between the acquired verification image and the corresponding reference image can be corrected on real time before applying the treatment. The data of 770 setup verification images acquired using EPID for different treatment sites for 152 patients have shown that the importance of the setup error verification before the treatment of radiotherapy patients. The results and its statistics show that the setup errors depend on the tumor site and the use of image verification technique (EPID) is an effective tool for patient setup verification. We recommend upgrading the radiotherapy treatment system to add other image guided verification modalities to improve the patient positioning and to be as a second option for patients need high image quality.

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