Assiut Univ. J. of Physics **Printed ISSN 1687-4900**
49(2), pp.50-66 (2020)

EVALUATION STUDY FOR ELECTRONIC PORTAL IMAGER SYSTEM DEVICE (EPID) AS QUALITY ASSURANCE AND DOSIMETRY TOOL FOR MEDICAL LINEAR ACCELERATOR MACHINE

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Received: 25/9/2020 **Accepted:** 2/11/2020 **Available Online:** 1/12/2020

Portal imager system now is widely attached as verification system in many models from linear accelerator due to may be used for treatment verification instead of film in as new ear for radiotherapy. The portal imager system has good properties for verification using imaging model and now with better treatment calculation algorithms for use as pretreatment verification for dose evaluation for some new radiotherapy techniques, and modern treatment delivery machines and modes of delivery, to improve possible for using the EPID the conventional Quality Assurance (QA) standards. **The current study was done used linear accelerator Varian (model UNIQUE™), which has single photon energy 6 MeV with different dose rate steps start from 100 MU/min. to 600 MU/min equipped by portal imager system aS500, absolute dosimetry system for standard calibration(farmer Ion chamber TM30013, MP3 water phantom and UNIDOS E™ electrometer). The aim of the current study was to quality assurance for the EPID after evaluate the usefulness of EPID method for Quality Assurance and Dosimetry Tool for Medical Linear Accelerator Machine.**

In the characteristics study, response of both the detector system, aS500 EPID found to be almost the same and comparable with ion chamber measurements and showed linear relationship with good agreement correlation coefficient of more than 0.974 in compared with absolute dosimetry and quality assurance tool for linear accelerator machine. The EPID system showed good response for different dose rate, different dose and comparable system for many tools using in Quality Assurance protocols for linear accelerator. Our results illustrate the EPID dosimetry can play an important and significant role in the total tests and experimental evaluation for verification procedures that are require for Radiotherapy output. It provides a safety net for easy method to verification advanced treatments, as well as a full account of the dose delivered images from electronic portal imaging device (EPID), which provide a high efficient tool to verify pretreatment verification delivery dose for advance radiation therapy.

Keywords: Linear Accelerator – Portal Dosimetry – Quality Assurance

1- INTRODUCTION

There are different sorts for pretreatment verification which include the portal dosimetry device, 2D- array gadget, and lots of dosimetry systems are usually use as relative dosimetric detectors for the planar dose evaluation of remedy making plans device (Treatment Planning System) versus measured doses and it changed the film dosimetry because of their short acquisition time, much less time eating, consistency and technical clean use [1, 2, 3]. Portal dosimetry device now could be commonly available in lots of fashions from linear accelerator due to may be used as exceptional assurance and calibration for clinical accelerator. Availability of recent detectors with improved characteristics, better remedy calculation algorithms for calculation predicted dose for evaluation plan within the present day remedy transport machines and modes of delivery, made possible to enhance at the conventional Quality Assurance requirements [4, 5, 6, 7, 8]. The validity of aS500 EPID and standard systems for calibration and first-rate assurance are still subject of controversy in the literature and conflicting facts were pronounced [9, 10].

There are different types for pretreatment verification such as the portal dosimetry system, 2D- array system, and many dosimetry system are commonly use as relative dosimetric detectors for the planar dose comparison of Treatment Planning System (TPS) versus measured doses and it replaced the film dosimetry because of their short acquisition time, less time consuming, consistency and technical easy use [1, 2, 3]. The goal of the current study was to calibrate the EPID and TPS and to evaluate the applicable use of EPID as the method for Quality Assurance and Dosimetry Tool for Medical Linear Accelerator Machine.

2- MATERIALS AND METHODS

An aS500 EPID with a Varian linear accelerator (model UNIQUE™) as shown in fig. 1, which has single energy 6 MeV photon beam. The EPID is attached to the gantry through a robotic arm and absolute dosimetry system for standard calibration (farmer ion chamber TM30013, MP3 water phantom and UNIDOS ETM electrometer). The energetic vicinity of The EPID for dosimetry mode is 28×28 cm^2 with 0.786 mm pixel size and the image size 512 x 384 pixel. It was used to accumulate photos. To carry out the imager dosimetric checking out, dose linearity reaction, lag, and symmetry of the EIPD have been studied. To verify linearity of the EIPD dose reaction versus added dose, 10×10 cm^2 images have been obtained at incremental MU irradiations from 10–600 MU, and the primary integrated pixel values (PIVS) according to MU were plotted in opposition to MU. The images have been received the usage of 6MeV beam electricity with dose rates start from one hundred to 600 MU/ min. Moreover, because the imager device for verification treatment positions, the EIPD signal changed into determined in a location of hobby (roi) of length 0.33×0.33 cm^2 at the middle of every photo frame. Subsequently, to verify the effectiveness of the aS500 backscatter protective layers, pass-aircraft and in-aircraft profiles were as compared thru the vital axis for one of a kind size square area pics, 2×2, 3×3, 4×4, 6×6, 8×8, 10×10, 15×15, 20×20, and 28×28 cm^2 . To confirm the linear response, detectors have been irradiated with a dose range of 2, 3, 4, 5, 8, 10, 15, 20, 25, 30, 35, 50, 75, 100, 250, 300, 400 and 500 MUS (in monitoring devices). The responses had been compared with the measurements of ion chambers. As the EIPD sign is calibrated for fixed dose charge the fluctuations in dose price can doubtlessly impact the response of EIPD as in case of dynamic IMRT and VMAT. So the linearity of EIPD to dose price was also established. On this observe dose of a 100 MU became introduced, included photo turned into obtained for 6 MeV beam with dose costs of 100 MU/min. To 600MU/min. Arc take a look at and ion chambers response to special dose quotes had been also studied. Discipline size reaction of the aS500 EIPD and ion chamber gadget with dosimetry electrometer similarly prolonged cable had been evaluated in assessment with ion chamber measurements, by turning in 50 MU. And evaluation the dose costs response of 300 MU/min for the sector sizes of 2x2 cm^2, 3x3 cm^2, 4x4 cm^2, 5x5cm^2, 6x6 cm^2, 8x8 cm^2, 10x10 cm^2, 15x15 cm^2, and 20x20 cm^2. After parameter identification, to validate the model, the modeling outcomes had been in comparison with the dimension outcomes. For validation, integrated epid photographs for IMRT field's pelvis plan were received at 6MeV strength and 100 cm SDD at gantry angle zero degree. Introduced dose of every field became recalculated for the equal fluence however modified dose price and doses.

This changed done to better allow contrast between consequences for the absolute dose and profile matching. All doses are absolute dose because the version converts EPID grayscale pics to absolute dose in Gy (i. E., no normalization is finished). The model was then used to confirm pretreatment IMRT deliveries through evaluation to eclipse dose planes for the equal fields at 10 cm depth using both 3%/3 mm and 2%/2 mm standards. The IMRT fields have been calculated one at a time on a virtual MP3 water phantom and farmer Ion chamber 0.6 cm^3 with 90 cm SSD and the isocenter at 10 cm intensity. Doses have been calculated with at 1. 5 mm grid size and the 3-dimensional DICOM dose report exported. The TPS dose aircraft at 10 cm intensity turned into then extracted for contrast to the EPID modelled dose.

Fig (1): *UNIQUE™* Linear Accelerator - Single Photon Energy Beam

3-RESULTS AND DISCUSSIONS

In the characteristics comparison take a look at the measured values for unique monitor units had been analyzed for device. As show in Fig. 2 Good agreement based on conventional Quality Assurance between calculated dose for point dose and point dose using EPID system, with 1.5% difference as average values for all measured. Each detector Show off first-rate linearity with display unit (MU) ranging 10MU to 600 MU and it became in comparison with the ion chamber results as shown in fig. 3. The determine suggests the dose charge response of aS500 EPID and remedy planning system in assessment with the ion chamber measurements. The detector panel did not show off any widespread dose price based saturation in reaction with the dose rate variety 100 MU/min to 600 MU/min (< +/- zero. Five %). Fig. 4 shows the sphere length dependence of aS500 EPID and treatment planning gadget in assessment with the ion chamber consequences. The consequences have been similar with the ion chamber measurements. With values normalized to 10x10 cm^2 subject size, the information sets for all detectors have been similar. Detectors showed similar reaction on SDD variation. The effects were compared with the ion chamber measurements as proven inside the parent 2. Each the detectors confirmed excellent short term balance and temperature balance as shown inside the figure 3 and discern in fig. 4. As noted from Figure 5, there is a slight difference between the three methods of calculating the dose, which is almost identical to the increased depth and showed similar reaction on SDD variation. For all the parameters the Karl Pearson correlation coefficient confirmed appropriate settlement and linear relationship with value of more than 0.94. The consequences of gamma assessment for ten dynamics and many instances have been tabulated as proven inside the desk 1 inside the planar dose. The consequences of point dose evaluation for 10 cases had been tabulated as shown within the table 1. Inside the planar dose evaluation, the portal dosimetry, TPS and ionization chamber in suitable settlement to every both.

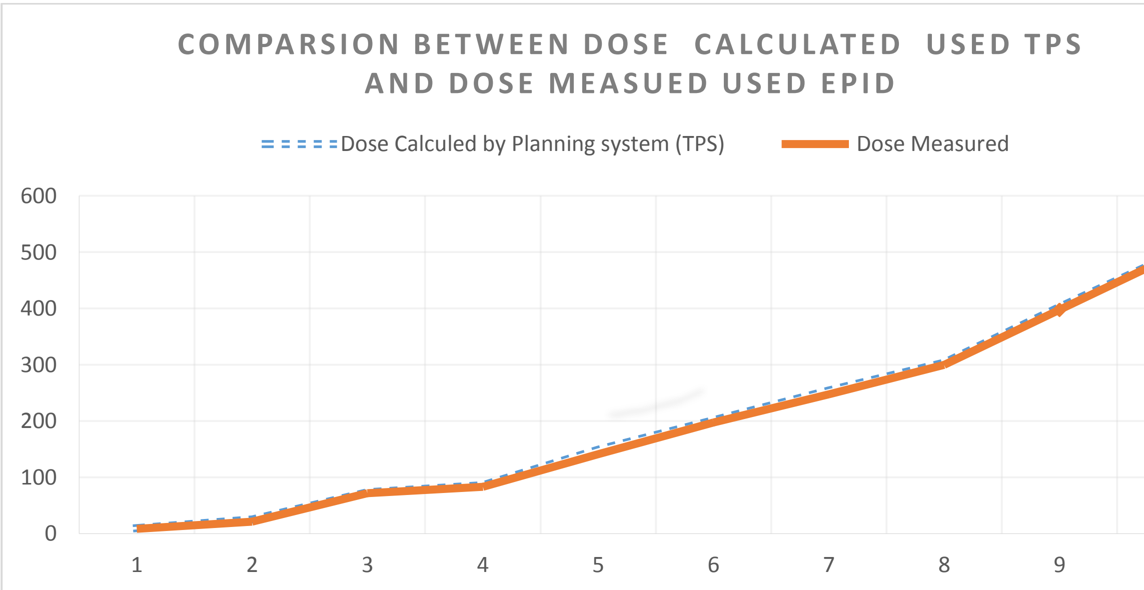


Fig (2): comparison between dose calculated by TPS and dose measured used EPID

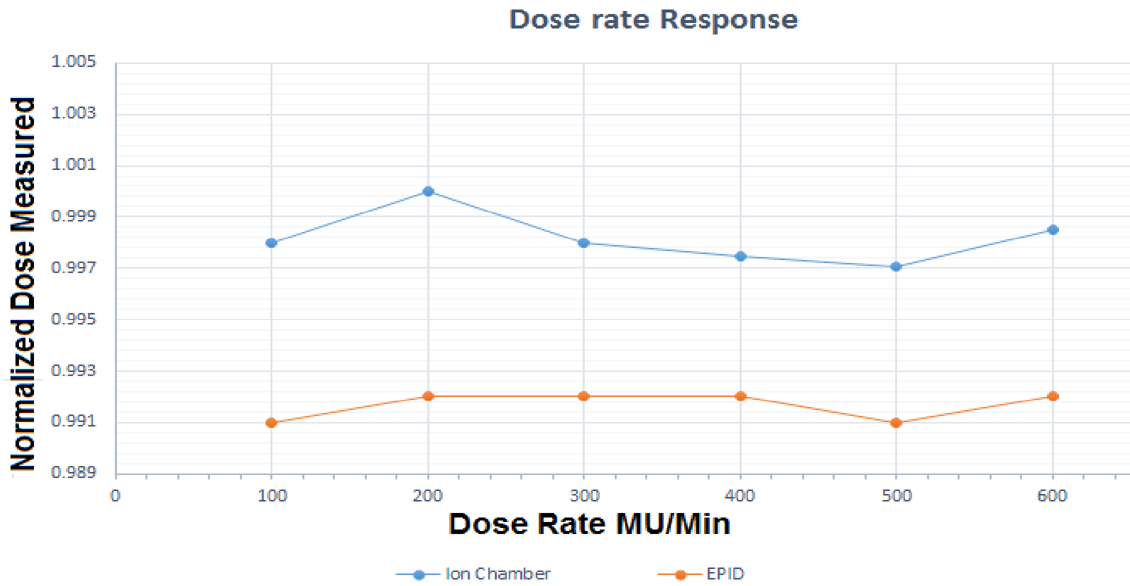


Fig. (3): the dose rate response comparison between EPID versus ionization chamber 0.6cc for different steps of dose rate start from 100 MU/ Min to 600 MU/min.

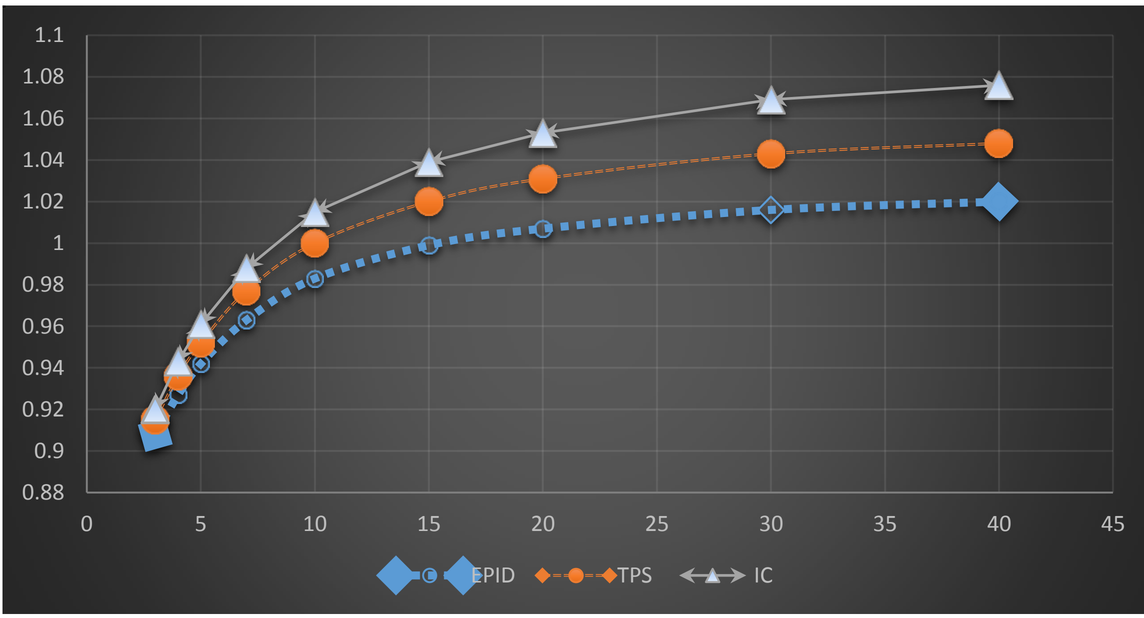


Fig. (4): Different field size depends for comparison between aS500 EPID, Treatment Planning System (TPS) and Ionization Chamber.

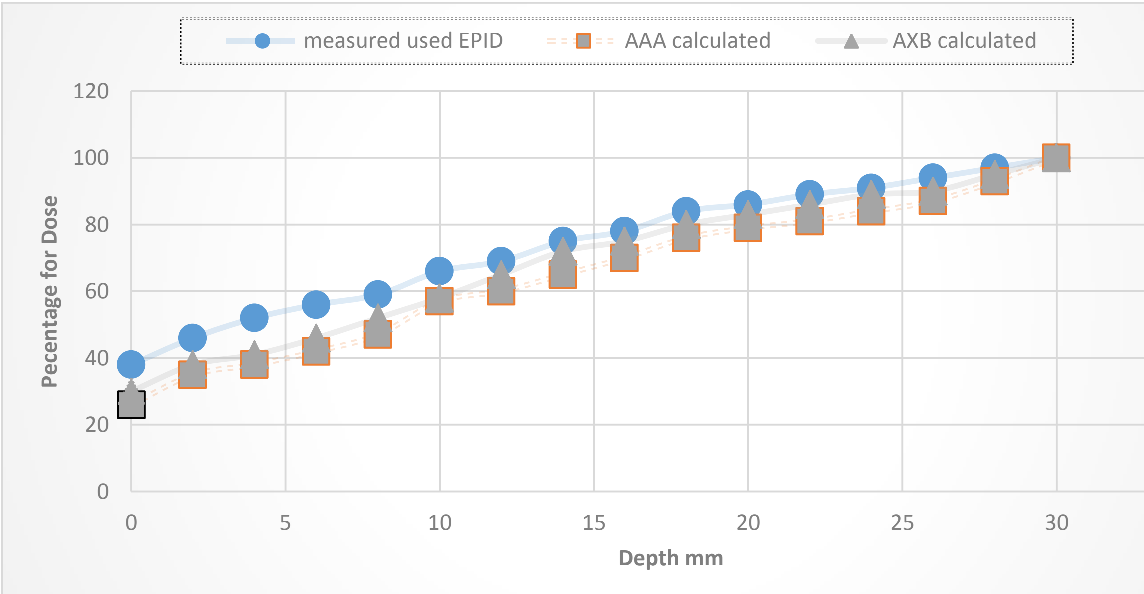


Fig. (5): Different field sizes output dose for comparison between EPID versus Treatment Planning System algorithms (AAA and AXB for Eclipse treatment planning system Varian)

As shown in Fig (6) the flatness parameter and symmetry for different field good agreement between the data measured using relative dosimetry system and transfer for treatment planning system with date measured using EPID system, and matching more than 99.7 % between measured and calculate d by TPS. Electronic portal imaging devices (EPIDs) have been the preferred tools for verification of patient positioning for radiotherapy in recent decades. Since EPID images contain dose information, many groups have investigated their use for radiotherapy dose measurement. With the introduction of the amorphous-silicon EPIDs, the interest in EPID dosimetry has been accelerated because of the favorable characteristics such as fast image acquisition, high resolution, digital format, and potential for in vivo measurements and 3D dose verification.

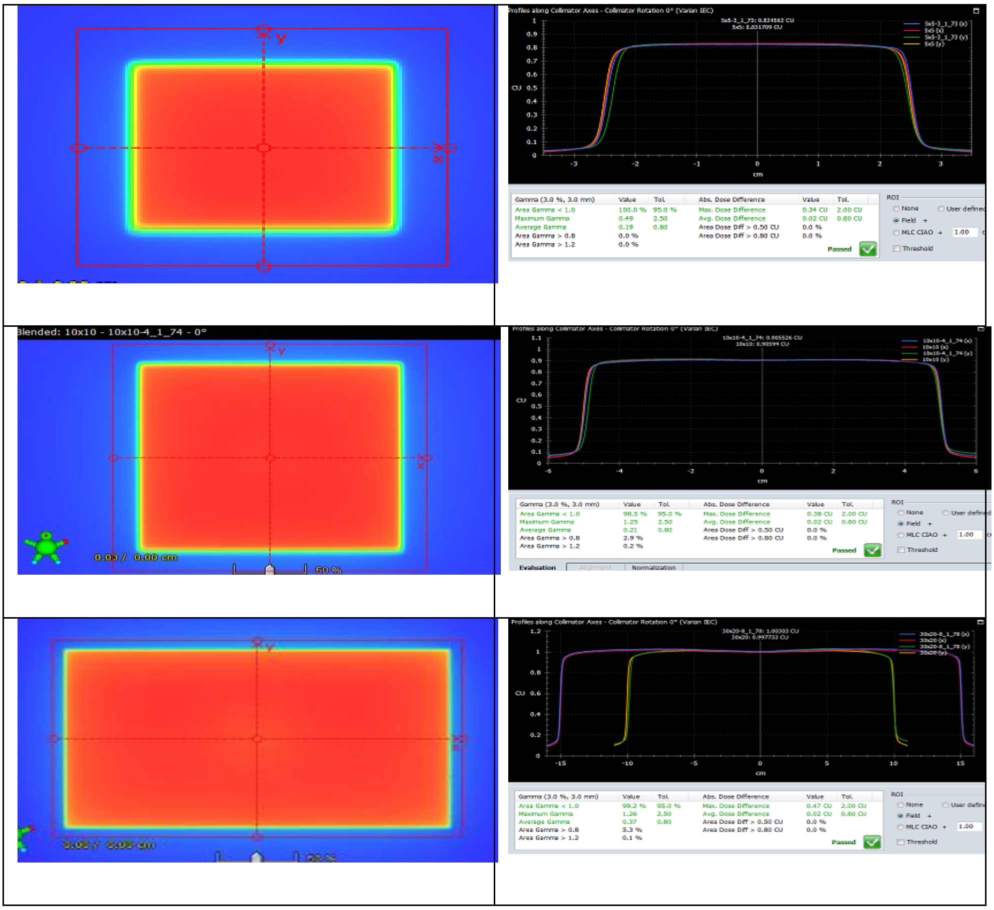
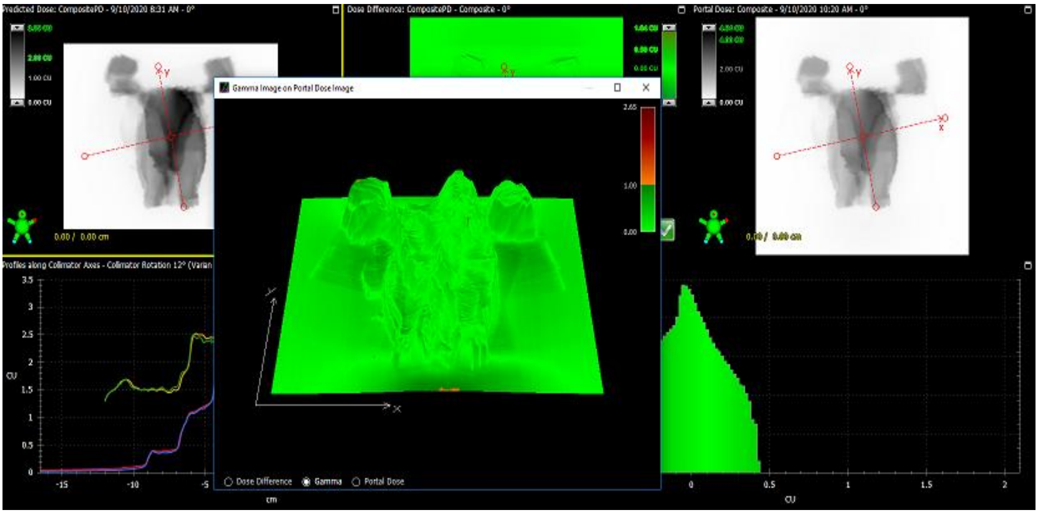


Fig.(6) : flatness and symmetry test using EPID in compared with Treatment planning system data results for the same parameter for three field size 5 cm , 10 cm and 20 field size.

As shown in fig (7) As a result, the variety of guides handling EIPD dosimetry has elevated notably over the past 10 years. The reason of this paper become to study the information furnished in those courses. Statistics to be had in the literature protected dosimetric traits and calibration processes of various forms of EIPDs, techniques to use EPIDs for dose verification, medical tactics to EIPD dosimetry, starting from factor dose to complete 3D dose distribution verification, and current scientific enjoy. Quality manage of a linear accelerator, pre-remedy dose verification and in vivo dosimetry the use of EPIDs at the moment are automatically utilized in a growing variety of clinics. Using EPID for dosimetry purposes has matured and is now a dependable and correct dose verification approach that can be used in a large quantity of situations. There may be nonetheless a loss of commercially available answers for EIPD dosimetry. As techniques evolve and business merchandise turn out to be to be had, EPID dosimetry has the capability to become an accurate and efficient method of big-scale affected person-unique IMRT dose verification for any radiotherapy department. As shown in fig. (8), the linear response for EPID for different dose (MU) with value $R^2 = 0.9996$. It is also noted from Fig. 9 that the change in the measured dose increases with the field size and also noted the sensitivity of the EPID device to this increase and also noted the extent of the approach of the dose measured between the three devices.



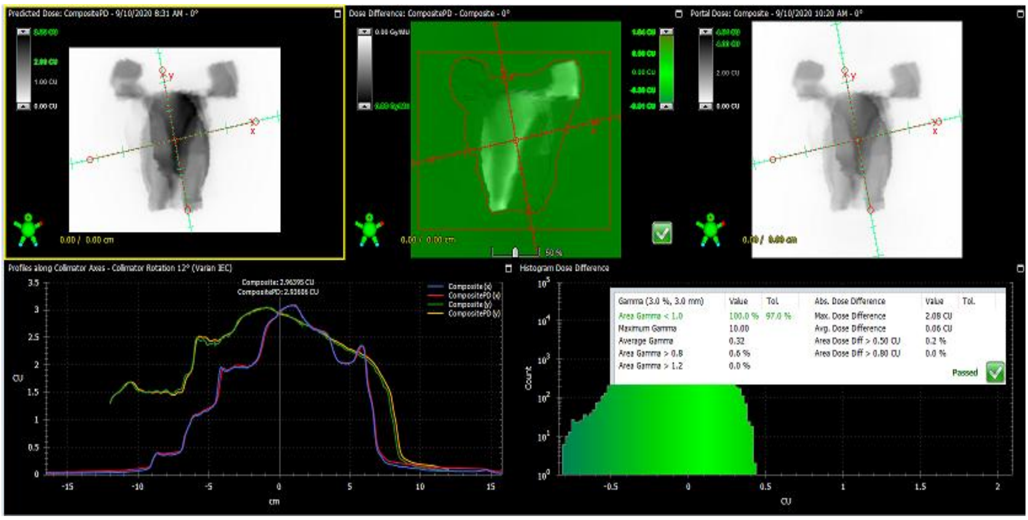


Fig. (7): the 3D verification Dose for Pelvis case and profiles matching between calculation and measurement by EPID

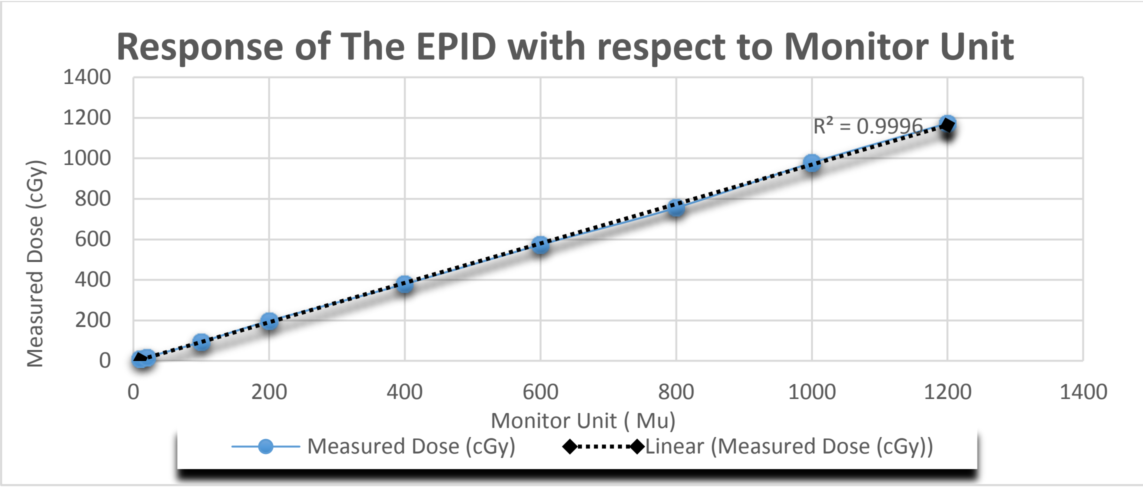


Fig (8): EPID response for different Monitor Unit (MU)

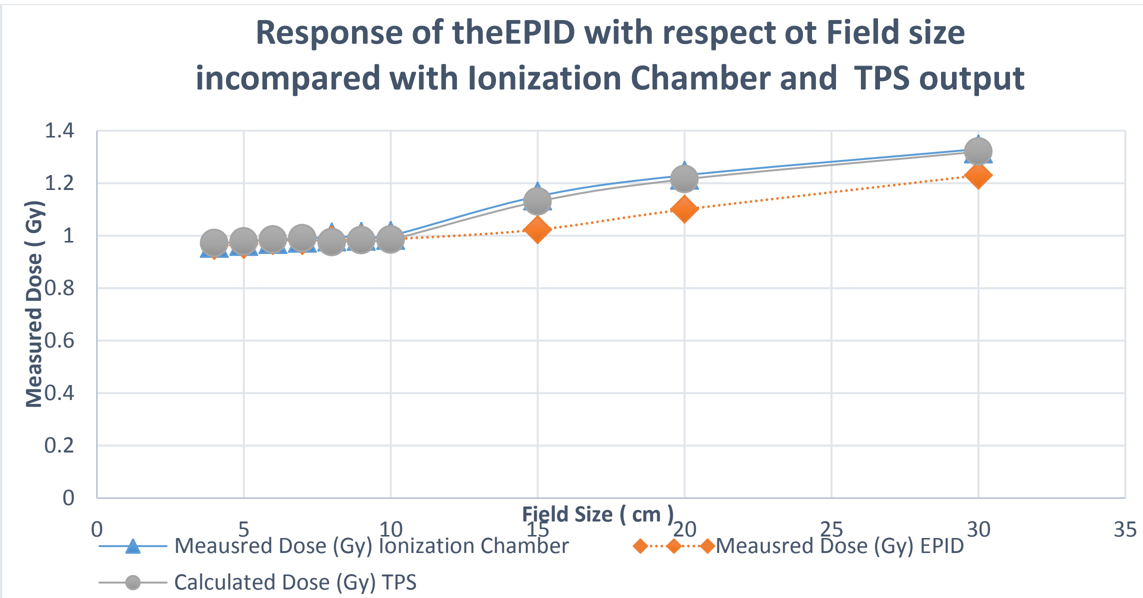


Fig. (9): the response of the EPID output for different field size from 3x3 cm² to max field size 30x30 cm² in compared with IC and TPS.

3-1 MODEL PERFORMANCE

Finally, the modeled dose and ionization chamber were compared to the TPS dose for the same fields. The comparison results have been summarized in Table 1. Data normalized to TPS as (100%)

Table 1. Pretreatment verification using the model compared to TPS dose at 10 cm depth.

Case No.	*EPID %*	*IC%*
1	***97.85***	***100***
2	***98.2***	***100***
3	***98.5***	***99.5***
4	***99.1***	***100***
5	***98.52***	***100***
6	***98.13***	***100***
7	***97.95***	***99.8***
8	***99.2***	***99.6***
9	***99.4***	***100***
10	***98.95***	***100***
Mean (SD)	***98.1(1.5)***	***100(0.0)***

3-2 DISCUSSION

Studies of dosimetric traits are important before using any dosimetric tools for the clinical cause. Nowadays portal dosimetry and a couple of 2D-array verification structures are widely followed for the first-rate warranty for medical linear accelerator due to their awesome dosimetric characteristics and easiness to use. Dosimetric homes of aS500 EPID and ion chamber device proved its well worth over antique gadget movie and different dosimetric gadget. Higher understandings of the dosimetric characteristics are required for the improvement of an effective and green algorithms and measurement tools for the better accuracy. Within the characteristics study, reaction of each the detector device, aS500 EPID found to be similar and similar with ion chamber measurements and showed linear relationship with Karl Pearson correlation coefficient of more than 0. 999 both the detector gadget confirmed proper response for exceptional dose fee and exclusive dose and comparable system for plenty equipment the use of in quality guarantee protocols for linear accelerator. With the introduction of aS500 EPID, character field verification can be done very efficiently with a superb spatial decision. The dangers of the 2D-array machine are the low resolution of the detectors and the time taken to installation the detectors and phantom and to hook up with the outside laptop device with analysis software. On this examine, the values received in patient specific fine warranty measurements with the portal dosimetry machine were determined to be fantastically greater constant compared to the ones received with nice warranty system like profiler for test the flatness and symmetry for beam and absolute dosimetry like ionization chamber device.

4-CONCLUSIONS

I n contemporary paper it's been proven that epid dosimetry can play an important position in the overall chain of verification procedures which are implemented in a radiotherapy department. It provides a safety net for easy to advanced treatments, as well as a complete account of the dose delivered pix from digital portal imaging tool (EPID) provide an efficient tool to verify remedy machine and delivery dose for radiation therapy

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دراسة تقييمية لجهاز التصوير الالكترونى المدخلى كأداة لضمان الجودة و قياسات الجرعة لجهاز المعجل الخطى الطبى

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إن جهاز التصوير المدخلي الان يستخدم علي مجال واسع في الكثير من نماذج المعجلات الخطية الطبية حيث يكون مرتبط بيها مما سمح باستخدامه كأداة للتحقق من طرق العلاج بدلا من الافلام العادية مما أذن لبداية عصر جديد في مجال العلاج الاشعاعي. إن التصوير المدخلي لديه العديد من الخصائص التي تساعد علي التحقق من العملية العلاجية بطريقة صحيحة منها مثلا باستخدام نموذج التصوير، و لكن الان توجد طريقة جديدة و هي باستخدام خوارزميات حساب العلاج لاستخدامها في التحقق قبل المعالجة لتقييم الجرعة لبعض تقنيات العلاج الإشعاعي الجديدة، و كذلك أجهزة توصيل الجرعة الحديثة و نظم التوصيل (برمجيات المستخدمة لانتاج نظام التشغيل) و ذلك لتحسين إستخدام جهاز التصوير

المدخلي كأداة مالوفة في معاير أو قواعد أختبارات توكيد الجودة الخاصة بالمعجلات الخطية الطبية.

المواد والأساليب:

تم إجراء الدراسة الحالية باستخدام معجل خطي من تصنيع شركة فاريان (موديل UNIQUE™)، الذي يمتلك طاقة فوتونية واحدة MV ٦ مع معدل جرعة إشعاعية مختلفة تبدأ من MU/min ١٠٠ إلى MU / min ٦٠٠ و مرتبط معه جهاز تصوير مدخلي من النوع aS500، نظام قياس الجرعات المطلق للمعايرة القياسية، كان الهدف من الدراسة الحالية معايرة ضمان الجودة لجهاز التصوير المدخلي بعد تقييم فائدة طريقة إستخدام جهاز التصوير المدخلي كأداة لضمان الجودة و قياس الجرعات الاشعاعية لأجهزة المعجلات الخطية الطبية.

النتائج والمناقشات:

من خلال الدراسة التخصيصية وجد أن ستجابة كل من نظام الكاشف، و جهاز التصوير المدخليAS500 وجدت أن تكون تقريبا نفس وقابلة للمقارنة مع قياسات غرفة التأين وأظهرت علاقة خطية مع معامل ارتباط اتفاق جيد من أكثر من ٠.٩٧٤ في مقارنة مع قياس الجرعات المطلقة وأداة ضمان الجودة (المستخدم فيها غرفة التأين)لجهاز المعجل الخطي الطبي. لقد أضهر جهاز التصوير المدخلي خلال الدراسة أستجابة سريعة و مذهلة في التعامل مع التغير في الجرعة و معدل الجرعة و كذلك الادوات المستخدمة في برتوكالات ضمان الجودة و قياس الجرعات الاشعاعية لاجهزة المعجلات الخطية الطبية

الاستنتاجات:

من نتائجنا توضح أن قياس الجرعات باستخدام جهاز التصوير المدخلي مكن أن يلعب دورا هاما ومميزا في مجموع الاختبارات والتقييمات التجريبية لإجراءات ضمان الجودة لاجهزة المعجل الخطي التي تتطلب لإنتاج جرعة إشعاعية مظبوطة و لكي نحقق خطة علاجية صحيحة. كما أنه يوفر طريقة سهلة للتحقق من العلاجات المتقدمة، فضلا عن حساب كامل للجرعة التي تم تسليمها الصور من جهاز التصوير المدخلي والتي توفر أداة عالية الكفاءة للتحقق من الجرعة الواصلة للمريض و كذلك التحقق طريقة العلاج و خطوات تنفيذها.