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Gamma Passing Rate – Correlation with Patient Specific Quality Assurance Devices using Two Photon energies in Pelvic IMRT

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The effect on Gamma Passing Rate is studied by changing the Photon Energy in the Patient Specific Quality Assurance in Pelvic IMRT using EPID and MatriXX keeping PSQA device at Isocenter. Dose verification of 62 patients, suffering from pelvic malignancies and treated with Intensity modulated radiation therapy (IMRT), with EPID and MatriXX using gamma criteria of 3%/3 mm, 3%/2 mm, 2%/3 mm, 2%/2 mm and investigated the effect on Gamma Passing Rate (%GP) by changing beam energy from 6 MV to 10 MV. The results demonstrated that the behavior of gamma passing rate decreases as criteria is changed from 3%/3 mm to strict criteria. The mean gamma passing rate for 6 MV beam were (%GP±Standard Deviation σ) 99.64±0.81, 99.45±1.08, 97.57±2.12, 96.17±2.63 using the criteria 3%/3 mm, 3%/2 mm, 2%/3 mm, 2%/2 mm respectively in EPID. For MatriXX, the mean %GP were 96.69±4.11, 93.85±5.31, 88.17±10.63, 82.2±12.28 respectively. For 10 MV, the mean (%GP±Std. Dev) were 99.64±0.81, 99.45±1.08, 97.57±2.12, 96.17±2.63 for in EPID, 96.69±4.11, 93.85±5.31, 88.17±10.63, 82.2±12.28 for MatriXX respectively. Difference between %GP for 6 MV and 10 MV beam were -0.01, -0.11, 1.08, 1.61 with gamma criteria of 3%/3 mm, 3%/2 mm, 2%/3 mm, 2%/2 in EPID. For MatriXX, difference between %GP for 6 MV and 10 MV beam were -0.40, -0.24, 0.96, 1.62 respectively. It can be concluded that applying more strict gamma criteria results in low gamma passing rate. There is marked difference in Gamma Passing Rate (%GP) with change in photon energy.

Keywords: Gamma Analysis; IMRT; MatriXX; EPID; PSQA; Pelvis; Gamma Passing Rate; 6 MV & 10 MV Photon Energy

1 Introduction

With the availability of Medical Linear Accelerators and Higher Modality Treatment Technique in Radiotherapy, the percentage of persons getting treatment on Linear Accelerators, LINAC - as it is commonly called, is increasing day by day. As compared to old treatment technique such as conventional or open field radiation therapy and 3D Conformal Radiotherapy (3DCRT), the advanced treatment technology such as Intensity Modulated Radiotherapy (IMRT), Volumetric Modulated Arc Therapy (VMAT) or Rapid Arc provides uniform and desired dose distribution to the Target Volume. This in turn results in adequate sparing of normal tissues and uniform dose to target volume.

The Radiation Therapy is a combination of Cancer patient treatment planning on Treatment Planning System (TPS), treatment delivery on Linac, and Linac is controlled through Control Console outside the treatment room. Considering that lot of Hardware and Software is involved in treatment delivery, it is possible that, in spite of best efforts of radiation oncology team, errors may creep in causing invariant error in treatment delivery which may result in inconsistent delivery of treatment. To avoid the above situations, the patient specific quality assurance (PSQA) is recommended. The PSQA can be performed before or after the treatment but it is recommended that it should be performed before the start of treatment. For the quantitative evaluation of dose distributions Low *et al.*[1,3] proposed a method for QA. Various guidelines and recommendations are available to perform these tests or quality assurance (QA)[2, 4-7]

As per our best knowledge after literature review, it is the first study to be done on Pelvic Malignancies to study the effect of change in Gamma Passing Rate (%GP) due to change in beam energy keeping PSQA device at isocenter.

2 Materials and Methods

2.1 Patient Selection

To test the quality assurance devices, 62 patients having pelvic malignancies – Anorectum, Cervix,

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Endometrium, Prostate, Rectum, Urinary Bladder, Vagina Vault were chosen for PSQA.

2.2 TPS

For present study, the radiotherapy treatment plans were generated on Eclipse Treatment Planning System Version 13.6, Varian Medical System Inc., Palo Alto, CA, USA, using 6 and 10 MV photon beam. The calculation model used for Volume Dose is AAA_13.6.23 (Analytical Anisotropic Algorithm). For IMRT Optimization, the Photon Optimizer_13.6.23 algorithm was used. For Portal Dose Portal Dose Image Predication (PDIP) version 13.6.23 was used. During Optimization the Resolution was set to Normal 2.5mm mode.

2.3 Linear Accelerator

In this study all the measurements were performed on TrueBeam 2.5 linear accelerator supplied by Varian Medical System, Palo Alto, CA, USA. The TrueBeam is equipped with photon – 6, 10 and 15 MV and electron energies. The 6 and 10 MV photon energy was used in the present study. The Multi Leaf Collimator (MLC) with120 Leaves (120MLC – Radiation Oncology Version). The MLC system has 40 Leaves (20 pairs) with leaf width of 0.5 cm and outer pair has 20 Leaves (10 Pair) of with 1.0 cm at Isocenter. The TrueBeam is equipped with MV as well as kV Imaging Modalities.

2.4 PSQA DEVICE:

2.4.1 EPID

The MV Imager is Electronic Portal Imaging Device (EPID) with aS1000 (Amorphous Silicon Type Flat Panel). This device is attached with the TrueBeam. It performs two functions – Imaging as well as Portal Dosimetry. The portal dosimetry is used as Quality Assurance dosimeter. The EPID detector has four parts. - 1. 1 mm copper build up plate, 2. A scintillating phosphor screen. 3. Image forming sensitive layer. 4. Electronic Instrumentation. The image forming layer is a 512X384 matrix deposited on glass substrate. Each pixel in the matrix has a 0.784 mm pitch and consists of Si-n-i-p photocathode to integrate the incoming light into charge capture and a thin film transistor.

Verification Plan

The radiotherapy treatment plan was created on the Eclipse Treatment Planning System using inverse planning IMRT technique. Thereafter, a verification plan was created using Portal Dose Prediction keeping Source-Imager Distance (IEC 61217) 100 cm. The beams were investigated at the actual treatment angle. All the beams were kept in the same verification plan. The portal dose images were calculated without patient for all the planned fields using PDIP algorithm. This algorithm used convolution of primary beam intensity and detector response function to calculate the verification plan. This plan was scheduled for verification. In the scheduling work space INTEGRAL IMAGE were added to each beam and the plan is approved for delivery. For PSQA, this plan was used. Couch was fully outside the beam. And the photon beam was directly perpendicular to EPID.

The individual measured field is aligned to the reference image. The composite image is created by selecting all the images of the aligned measured field. On this composite image the Gamma Analysis was done. The predicted plan and measured plan were compared using Improved Gamma Evaluation using the various parameters such as Area Gamma (95%), Maximum Gamma (3.5), Average Gamma (0.5) and Dose Difference Tests with Maximum Dose difference less than 1 Calibration Unit.

2.4.2 MatriXX

The quality assurance system is supplied by IBA Dosimetry, GmbH, Germany. It consists of software OmniPro-I'mRT^{+} and hardware QA device MatriXX^{Evolution}. This tool is commonly called IMatriXX or simply MatriXX. It consists of Ionization Chambers (IC) covering an active field of 24.4 cm X 24.4 cm. The sensors are vented pixel IC. The IC are arranged in a 32 cm X 32 cm grid except for the four corner positions where chambers are missing. The distance between the individual chambers is 7.62 mm centre to centre. The housing material is ABX Tecaran (density: 1.06 g/cm^3). The effective point of measurement is 3 mm below the housing surface (water equivalent depth: 3.3 mm). The alignment marks on the sides of the device indicate this position.

Gantry Angle Sensor

The Gantry Angle Sensor (GAS) is used for online detection of the gantry angle of linac while irradiating for dose measurements. It measures the angle positions for all measured frames. The GAS used bulls eye spirit levels in two perpendicular directions for levelling at Gantry Angle 0^0 and Gantry Angle 90^0. The two lock screws lock the position when the final position is reached.

The measuring system is connected to the Main Software through Ethernet interface. The measured data is then transmitted to PC via standard Ethernet interface in the PC.

Configuration**:** Before using the MatriXX for measurement and acquiring data, the following steps were performed. This was one time procedure

1. Scanning the MatriXX along with the RW3 plate on CT scan. The setup consists of stacking of 10 RW3 plate side by side and on these 10 plates the MatriXX was placed. Again, only on the detector area 5 plates were placed. Thereafter on the side that is on the alignment marks two small lead balls were placed and there after CT scan was performed.
2. The CT images were exported to the Eclipse using DICOM format.
3. In the Eclipse the images were imported and structure set was created in the TPS. And Body was contoured on the slices.

Whenever any verification plan of a patient was to be created for PSQA using MatriXX, this phantom structure set will be used.

Verification Plan

This is a two steps procedure.

1. The Verification Plan was created in the TPS using above created structure set. The beams were investigated at the actual treatment angle. All the beams were kept in the same verification plan. The dose was calculated without patient for all the planned fields. This plan was scheduled for verification.

2. Export of Dose Plane: Dose should be in Absolute Dose mode. First select the Frontal View in the verification Plan. Then select the first field and select Move Viewing Planes to Isocenter/Entry Point. Right click on the Dose and click Export Dose Plane to the PC on which OmniPro-I'mRT^{+} is installed.

Import the dose plane on the PC on which OmniPro-I'mRT^{+} is installed.

Performing the PSQA on the TrueBeam using QA Mode and MatriXX.

For performing the PSQA, In the treatment room, the IGRT Couch Top was moved to the position: Lateral position was set to 0, Vertical position was set to 13.5 and Longitudinal position was set to 140. This particular position was chosen because the thick part of the couch is generally used during Pelvis treatment. The MatriXX was set on the IGRT Couch as it was set on the CT Scan Machine. The centre of the device was matched with the cross wire of collimator. Only couch vertical motion was performed for matching the alignment marks on device with the lateral laser. The GANTRY ANGLE SENSOR was connected to the MatriXX. The Ethernet was connected to the PC outside the treatment room and power was supplied to the unit.

After the initial set up was done in the treatment room, the MatriXX was connected with the software. A white checkmark within Green Circle indicates correct setup. In the Gantry 0^0 and Collimator 0^0, Field size 25cm X 25cm was opened. The irradiation was done with 500 MU's to sensor area. Compensate Background was done using 20 sec as sampling time. A white checkmark within Green Circle indicates that background measurement was successful. A drop-down menu on background tab was clicked to view defect pixels if any. Only 3 times during the entire measurement period defect pixel was seen.

The GAS was calibrated every time the software is run. It was a 3-step procedure. When it was calibrated, a white checkmark in green circle appears.

Clicking the setting menu opens the measurement configuration. Before the calibration was done, every time the energy was selected in this menu. There after the position of the detector that is MatriXX. was chosen. In present study detector was always kept on couch. The SDD was fixed at 100 cm and 5 cm buildup thickness was used. The buildup material used was RW3 plates. Calibration was performed with specific energy 6 MV and 10 MV and was stored in the software. The calibration was valid for 3 months but was performed every 15 days to get accurate results. The parameters used for calibration are – For 6 MV, 100MU for 10 cm X 10 cm field size, The dose was 95 cGy. And for 10 MV, 100 MU for 10 cm X 10 cm field size, the dose was 101 cGy.

After all the calibration was done and saved the measurement was performed using the setting such as Search distance of 4.5 mm and threshold value set to 5%.

2.5 Gamma Dose Analysis

Gamma Analysis is the most commonly used method for comparison of dose distributions for PSQA in radiation oncology. The Gamma Evaluation or Gamma Analysis or Gamma Index Analysis was developed by Low *et al.*[1,3] and is widely used by physicist to perform PSQA on different QA devices. The Gamma Analysis compares measured dose distribution with a calculated dose distribution in a quantitative way by calculating the Gamma Value of each point. This Gamma Value is the minimum Euclidean distance in the dose spatial region. The agreement between measured and calculated dose distributions is calculated using two acceptance criteria –

1. Dose difference, ΔD, in % and 2. Distance-to-Agreement, DTA, in mm. The Gamma Analysis produces Gamma Index Values. The Gamma Index Values ≤1 indicate passed or otherwise failed. The percentage of passing points in the Gamma distribution is referred to as Gamma Pass Rate (%GP). The ΔD and DTA criteria of 3%/3mm with 95% Gamma Pass Rate (95%GP) is frequently used criteria to assess the PSQA.

There are two types of Gamma Evaluation.

1-The Global Gamma Analysis normalized the percent differences for every point to a globally used single value, usually the maximum planned dose.

2-The Local Gamma Analysis normalized the percent differences for every point to the expected dose at each point.

The %GP calculated by Global Gamma Analysis will always be ≥ local gamma provided same ΔD and DTA criteria with same threshold value are used.

According to the Miften *et al.*[6] Global Normalization should be used because it is deemed more clinically relevant than local normalization. For more realistic measurement of the Gamma Analysis, the global point should be selected in a low gradient region. The Local normalization can be used during IMRT commissioning process.

3 Results

The Doses Calculated by TPS were compared with doses measured by the EPID and MatriXX using Gamma Evaluation. The percentage of points passing Dose Tolerance (DT) in percentage and Dose to Agreement (DTA) in mm for all combinations of 3%, 2%, 3 mm, and 2 mm, were utilized in the present study.

There were two sets of readings one each for beam energy 6 MV and 10 MV. Under each set, the gamma analysis was performed using the criteria 3%/3 mm, 3%/2 mm, 2%/ 3mm, 2%/2 mm for each QA device for each patient. The Gamma Threshold value 5% was used. No normalization and No correction were introduced in the results to obtained %GP. The results are discussed below.

3.1 Photon Beam: 6 MV

Individual patient Gamma Passing Rate (%GP) for 6 MV with 3%/3 mm criteria is shown in Fig. 1.

The Table 1 shows, for 6 MV with 3%/3 mm criteria, 61 patients on EPID and 47 patients on MatriXX passed the 95% test condition. Only 1 patient failed the 95% criteria on EPID whereas 11 patient failed the criteria on MatriXX.

Individual patient Gamma Passing Rate (%GP) for 6 MV with 3%/2 mm criteria is shown in Fig. 2.

With 3%/2 mm dose evaluation criteria, the number of patients passing %GP≥95% is 61 for EPID and 33 for MatriXX. As shown in Table 2 there are 29 patients failed the criteria of 95% gamma passing rate on MatriXX

Individual patient Gamma Passing Rate (%GP) for 6 MV with 2%/3 mm criteria is shown in Fig. 3.

Refer to Table 3 With 2%/3 mm dose evaluation, the number of patients passing %GP≥95% is 61 for EPID and 23 for MatriXX. There are 39 patients failed the criteria of 95% gamma passing rate on MatriXX.

Individual patient Gamma Passing Rate (%GP) for 6 MV with 2%/2 mm criteria is shown in Fig. 4.

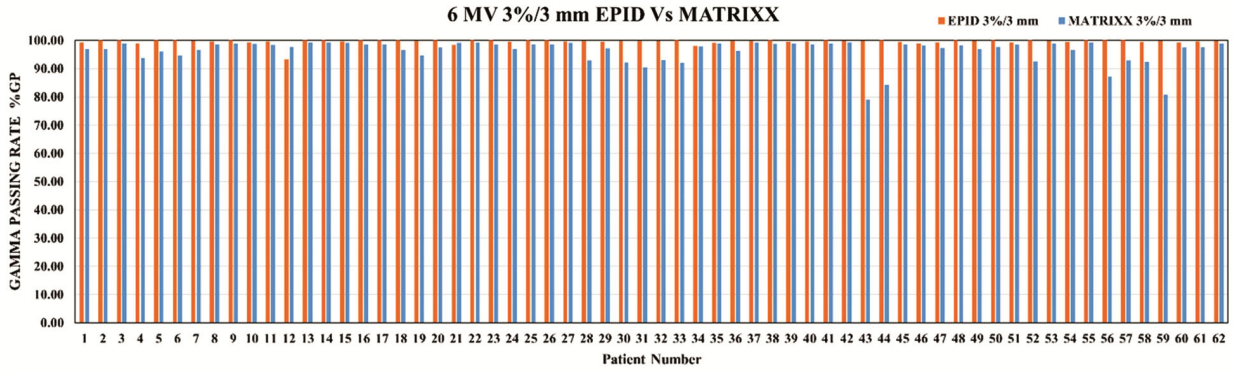

Fig. 1 — 6 MV 3%_3 mm EPID VS MATRIX

Table 1 — Dose Evaluation Distribution for 6 MV 3%/3 mm

	Mean±SD	No. of Patients %GP ≥95%	No. of Patients %GP <95% - ≥90%	No. of Patients %GP <90%
EPID 3% 3mm	99.63±0.89	61	1	-
MatriXX 3% 3mm	96.29±4.24	47	11	4

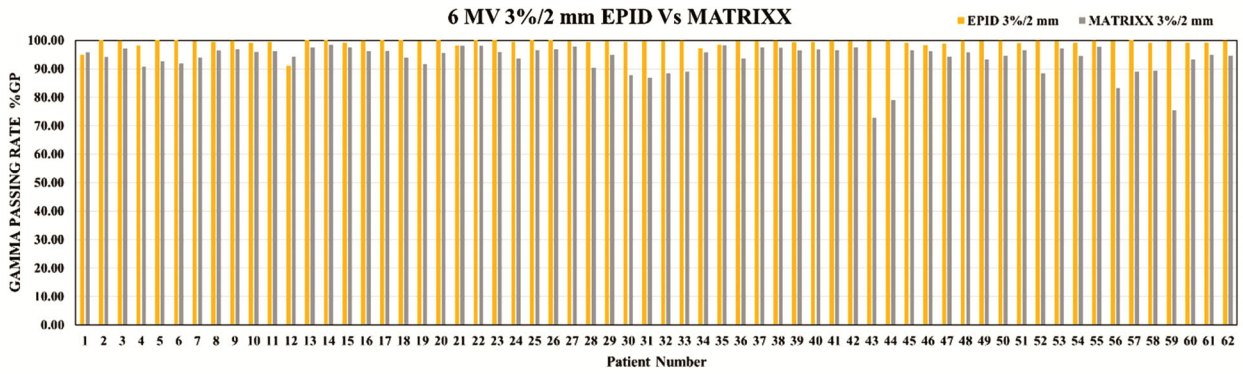

Fig. 2 — 6 MV 3%_2 mm EPID VS MATRIX

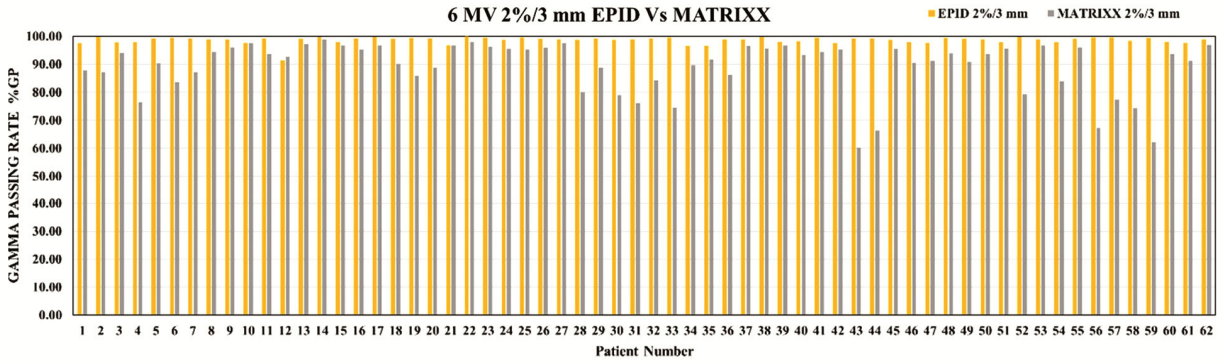

Fig. 3 — 6 MV 2%_3 mm EPID VS MATRIX

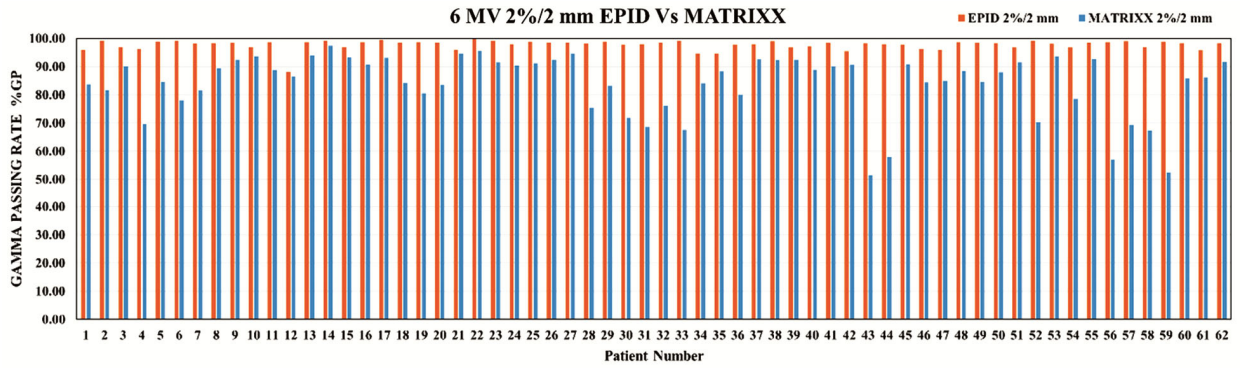

Fig. 4 — 6 MV 2%_2 mm EPID VS MATRIX

Table 2 — Dose Evaluation Distribution for 6 MV 3%/2 mm

	Mean±SD	No. of Patients %GP ≥95%	No. of Patients %GP <95% - ≥90%	No. of Patients %GP <90%
EPID 3% 2mm	99.34±1.33	61	1	-
MatriXX 3% 2mm	93.61±5.19	33	18	11

Table 3 — Dose Evaluation Distribution for 6 MV 2%/3 mm

	Mean±SD	No. of Patients %GP ≥95%	No. of Patients %GP <95% - ≥90%	No. of Patients %GP <90%
EPID 2% 3mm	98.65±1.24	61	1	-
MatriXX 2% 3mm	89.13±9.27	23	16	23

As observed in Table 4, in case of 2%-2mm, there is decrease in the passing rate of patients. As compared to EPID where there is marginal decrease in Gamma Passing Rate that is only 3 patients out of 62 patients lie below 95%GP there was sudden decrease in the gamma passing rate for MatriXX. Only 2 patients passing the test condition of 95% and 23 patients lie in the range of <95% - ≥90%.

The Dose Evaluation by different dosimeter for 6 MV is shown in Fig. 5.

3.2 Photon Beam: 10 MV

Individual patient Gamma Passing Rate (%GP) for 10 MV with 3%/3 mm criteria is shown in Fig. 6.

The 3%/3 mm Gamma Evaluation, using 10 MV photon beam, shows that 62 out of 62 patients passed the 95% criteria. In case MatriXX 50 out of 62 patients passed the same. 57 patients passed more than 90% criteria in MatriXX as shown in Table 5.

Individual patient Gamma Passing Rate (%GP) for 10 MV with 3%/2 mm criteria is shown in Fig. 7.

The 3%/2 mm Gamma Analysis shows 61 and 38 patients on EPID and MatriXX passed the 95% criteria respectively. 62 and 52 patients passed the 90% test respectively as shown in the Table 6.

Individual patient Gamma Passing Rate (%GP) for 10 MV with 2%/3 mm criteria is shown in Fig. 8.

Gamma evaluation with 2%/3 mm criteria shows that 3 patients on EPID and 39 patients on MatriXX failed the 95% criteria. Further as per Table 7, 59 patients pass the 95% criteria for EPID. Similarly, 23 patients on MatriXX passed the 95% criteria.

Individual patient Gamma Passing Rate (%GP) for 10 MV with 2%/2 mm criteria is shown in Fig. 9.

As per Table 8, Gamma Analysis with 2%/ 2mm criteria with 10 MV beam shows that, 50 patients on EPID and 5 patients on MatriXX out of 62 patients passed the 95% criteria. 12 patient and 57 patients failed the 95% gamma passing rate criteria.

The Dose Evaluation by different dosimeter for 10 MV is shown in Fig.10: Dose Evaluation Vs Mean %GP for 10 MV.

The Table 9 & Table 10 compares the mean results obtained between EPID and MatriXX. By calculating and measuring dose verification at isocenter the difference is much at 3%/3 mm but for strict gamma criteria of 2%/2 mm is comparable which is significant.

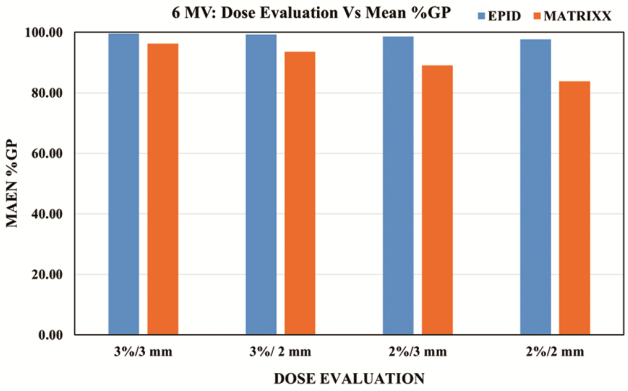

Fig. 6 — 6 MV Dose Evaluation Vs Mean %GP

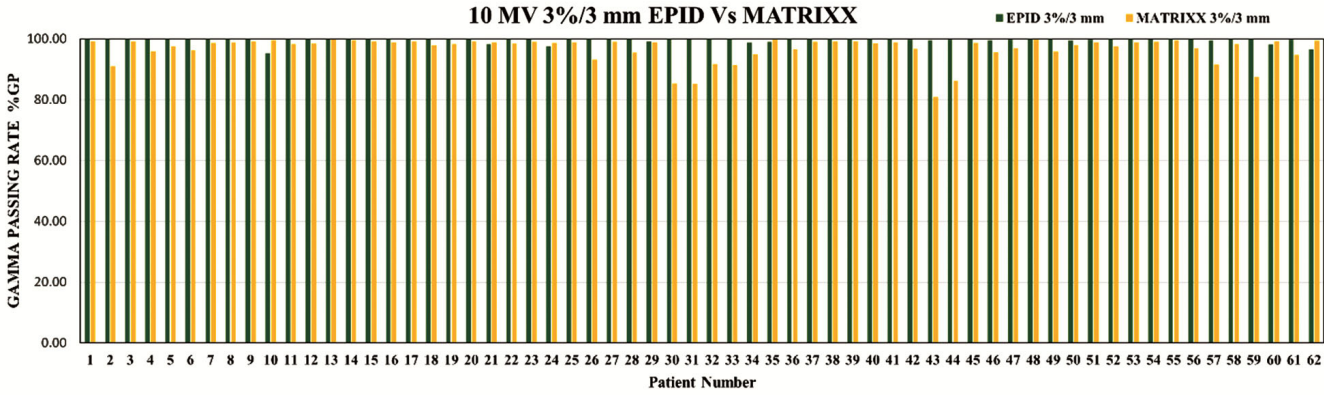

Fig. 5 — 10 MV 3%_3 mm EPID VS MATRIX

Table 4 — Dose Evaluation Distribution for 6 MV 2%/2 mm

	Mean±SD	No. of Patients %GP ≥95%	No. of Patients %GP <95% - ≥90%	No. of Patients %GP <90%
EPID 2% 2mm	97.78±1.70	59	2	1
MatriXX 2% 2mm	83.83±10.84	2	23	37

Table 5 — Dose Evaluation Distribution for 10 MV 3%/3 mm

	Mean±SD	No. of Patients %GP ≥95%	No. of Patients %GP <95% - ≥90%	No. of Patients %GP <90%
EPID 3% 3mm	99.64±0.81	62	-	-
MatriXX 3% 3mm	96.69±4.11	50	7	5

Table 6 — Dose Evaluation Distribution for 10 MV 3%/2 mm

	Mean±SD	No. of Patients %GP ≥95%	No. of Patients %GP <95% - ≥90%	No. of Patients %GP <90%
EPID 3% 2mm	99.45±1.08	61	1	-
MatriXX 3% 2mm	93.85±5.31	38	14	10

Table 7 — Dose Evaluation Distribution for 10 MV 2%/3 mm

	Mean±SD	No. of Patients %GP ≥95%	No. of Patients %GP <95% - ≥90%	No. of Patients %GP <90%
EPID 2% 3mm	97.57±2.12	59	1	2
MatriXX 2% 3mm	88.17±10.63	23	16	23

Table 8 — Dose Evaluation Distribution for 10 MV 2%/2 mm

	Mean±SD	No. of Patients %GP ≥95%	No. of Patients %GP <95% - ≥90%	No. of Patients %GP <90%
EPID 2% 2mm	96.17±2.63	50	9	3
MatriXX 2% 2mm	82.2±12.28	5	16	41

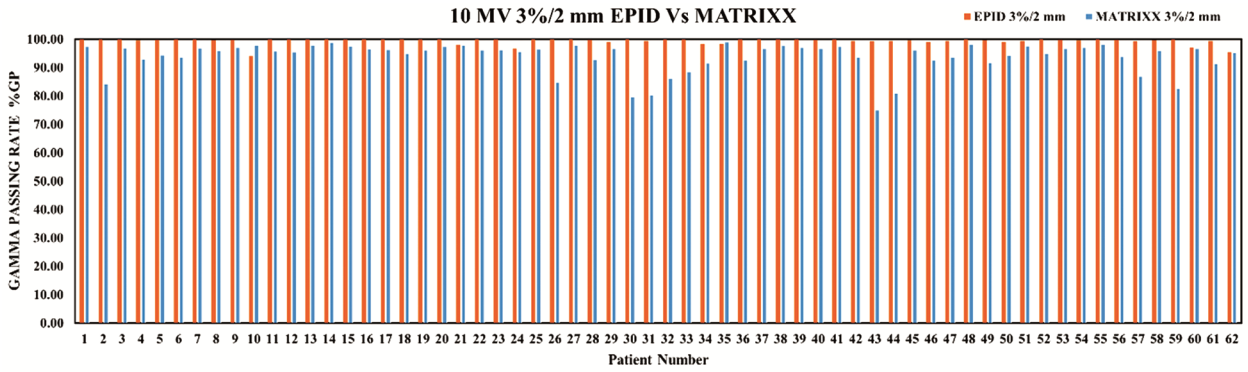

Fig. 7 — 10 MV 3%_2 mm EPID VS MATRIX

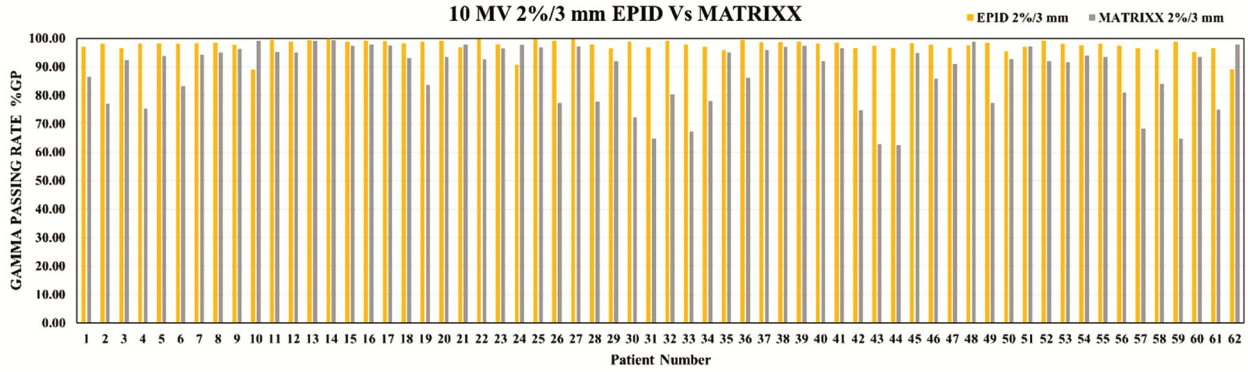

Fig. 8 — 10 MV 2%_3 mm EPID VS MATRIX

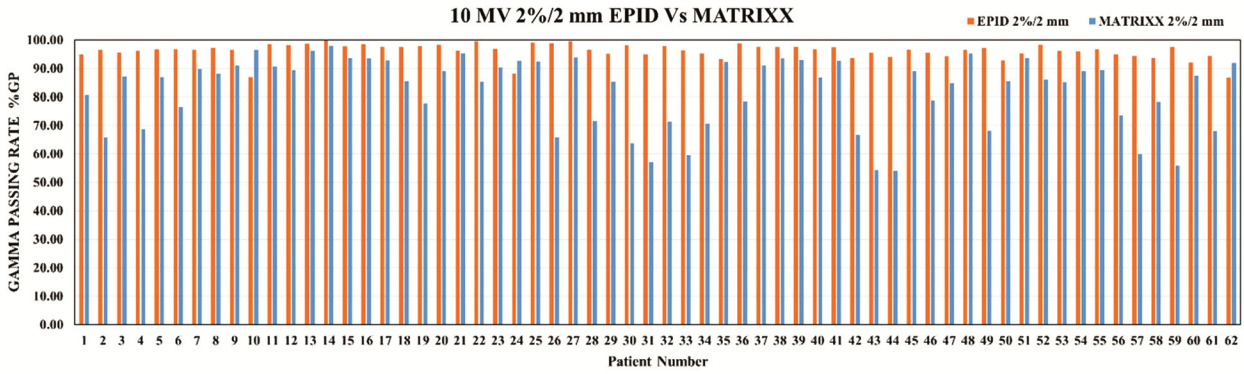

Fig. 9 — 10 MV 2%_2 mm EPID VS MATRIX

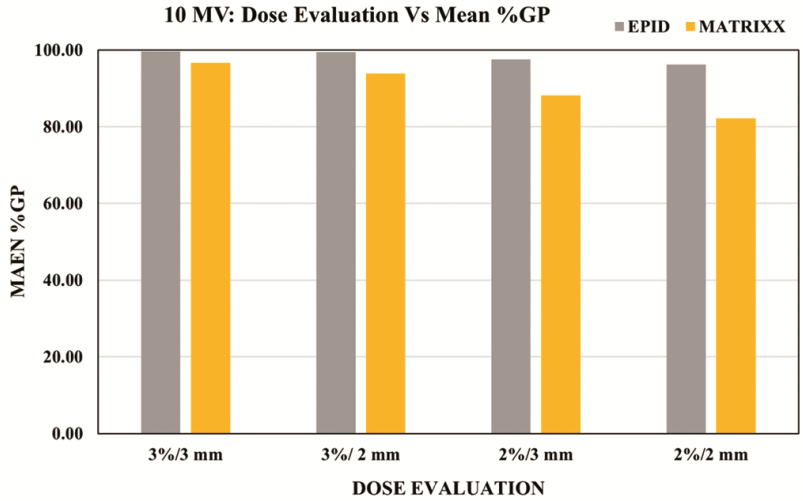

Fig. 10 — 10 MV Dose Evaluation Vs Mean %GP

Table 9 — Change in Mean %GP in EPID

EPID CRITERIA	MEAN %GP 6 MV	MEAN %GP 10 MV	DIFFERENCE BETWEEN MEAN %GP (6 MV -10 MV)
3%/3 mm	99.63	99.64	-0.01
3%/2 mm	99.34	99.45	-0.11
2%/3 mm	98.65	97.57	1.08
2%/2 mm	97.78	96.17	1.61

Table 10 — Change in Mean %GP in MatriXX

MATRIXX CRITERIA	MEAN %GP 6 MV	MEAN %GP 10 MV	DIFFERENCE BETWEEN MEAN %GP (6 MV -10 MV)
3%/3 mm	96.29	96.69	-0.40
3%/2 mm	93.61	93.85	-0.24
2%/3 mm	89.13	88.17	0.96
2%/2 mm	83.83	82.20	1.62

4 Discussion

Several studies had been performed on different types of QA devices.

In 2019, Kausar *et al*[8] demonstrated the mean passing rate in Head & Neck and Prostate using IMRT and VMAT treatment technology. In IMRT, for Prostate Diagnosis and Head & Neck cases, the authors reported %GP (Mean ± Standard Deviation) 97.9±0.76 and 98.88±0.24 using I'matriXX using 3%/3mm criteria. In the present study, the %GP for

pelvic cases is 99.63±0.89 using EPID with 6 MV photon beam with 3% 3mm with 5% dose threshold. In case of MatriXX, with same criteria, the results obtained are 96.29±4.24 which is comparable with results obtained by Kausar et al study.

A comparison of the QA of four dosimetric tools for IMRT was done by Son *et al.*[9] (2015). Authors performed PSQA on 5 patients using Mapcheck, MatriXX, EPID and Radio chromic Film. They used 3%/3mm criteria and the reported average %GP of 99.61%, 99.04%, 99.29% and 95.88% respectively. In the present study, the %GP for pelvic cases is 99.63±0.89 using EPID which is in good agreement with the study of Son *et al*. For MatriXX, in the present study the result is 96.29±4.24 which is slightly lower than the Son J *et al* study. It may be due to the fact that here number of patients (62) are more as compared to 5 patients studied by Son *et al*.

In 2019, Szczurek *et al.*[10] in their study on 40 patients (25 patients with Prostate Cancer and 15 with Endometrial Cancer) analysed %GP using MatriXX and Compass of IBA using the 3%/3mm, 2%/2mm and 1%/1mm criteria and 6 MV photon beam. The reported value was %GP 99.8±.49 and 99.03±.59 using MatriXX 2D Array using 3%/3mm in Prostate and Endometrial Cancer. In the present study, there were lot of malignancies were considered and the results obtained are %GP is 96.29±4.24 which is comparable to the study. In 2%/2mm, the reported value by Lukasz is 98.90±0.74 and 94.89±3.03 in Prostate and Endometrial Cancer. In the present study, the results obtained are %GP 83.83±10.84. There is about 9% difference between the values of Lukasz and present study. Also, in their study using 2D Compass they reported result of 97.75±2.14 and 87.76±5.39 for Prostate and Endometrial Cancer respectively. There is variation in the value of %GP in their study from 87.76±5.39 to 99.06±0.82 (For 3D Compass from IBA).

Yu *et al.*[11] (2019) performed analysis of dose comparison techniques for PSQA in radiation therapy using ArcCheck and SNC Patient Software version 6.2.2. Authors compared Gamma Analysis with alternative dose comparison techniques. Authors reported 99.1±1.1, 98.1±2.0, 97.3±.8, 94.8±2.9 for 3%/3 mm, 3%2 mm, 2%/3 mm, 2%/2 mm respectively for %GP with 5% dose threshold using Global Gamma Evaluation. In the present study, the results obtained are 99.63±0.89, 99.34±1.33, 98.65±1.24, 97.78±1.70 for 3%/3 mm, 3%2 mm, 2%/3 mm, 2%/2 mm respectively using EPID which are better than Liting team results.

In the study, Dosimetry for IMRT technique using Ion Chamber MatriXX with Back Projection Method using 6 and 10 MV photon by Widodo *et al.*[12] (2020), used MatriXX-FFF and Back Projection Method. In this method convolution between the planar dose of 2D Array and TPS with kernel function of the detector is used. They compared non-Build up (NBU) with Build-up Correction and thereafter calculated the %GP for 3%/3 mm, 3%2 mm, 2%/3 mm, 2%/2 mm criteria in Head (6 MV and 10 MV) and Head and Neck cases (6 MV and 10 MV).

Individual values are not available but from the Graph it can be concluded that Firstly, in the Case of IMRT Head using 6 MV, the value of Uncorrected %GP are 3%/3 mm (≈99%), 3%2 mm (≈95), 2%/3 mm (≈98), 2%/2 mm (≈92) whereas in case IMRT Head and Neck Case using 6 MV the %GP are 3%/3 mm (≈99), 3%2 mm (≈98), 2%/3 mm (≈97), 2%/2 mm (≈93). In the present study, the values for 6 MV Pelvic Cases, the values of %GP are 3%/3 mm (96.29±4.24), 3%2 mm (93.61±5.19), 2%/3 mm (89.13±9.27), 2%/2 mm (83.83±10.84). Except for 2%/2 mm, the %GP values are comparable with the study of P. Widodo. In case of 2%/2 mm, the values in the present study are on lower side. Secondly, in the Case of IMRT Head using 10 MV, the value of Uncorrected %GP are 3%/3 mm (≈98%), 3%2 mm (≈97), 2%/3 mm (≈95), 2%/2 mm (≈92). In case of IMRT Head and Neck using 10 MV, the value of Uncorrected %GP are 3%/3 mm (≈70), 3%2 mm (≈62), 2%/3 mm (≈50), 2%/2 mm (≈42). In present study that is 10 MV Pelvic Cases, the values of %GP are 3%/3 mm (96.69±4.11), 3%2 mm (93.85±5.31), 2%/3 mm (88.17±10.63), 2%/2 mm (82.2±12.28).

Each QA device behaves differently from each other. While EPID is easy to use that is integrated with TrueBeam, perform QA in less time but MatriXX takes time to set up. As compared to MatriXX software, the EPID software interface is easy to use. The exported data from Eclipse to PC of MatriXX have to properly renamed to differentiate between QA plans.

5 Conclusions

Applying more strict Gamma criteria results in lower Gamma Passing Rate of QA plans in any device. The strict criteria of 3%/2mm or 2%/3 mm in case of 6 MV and 3%/2 mm in case of 10 MV can be used in EPID in Pelvic Cases. For MatriXX, 3%/3

mm may be continued to be followed. Compared to MatriXX, EPID values are more consistent. There is marked difference in Gamma Passing Rate (%GP) with change in photon energy. The strict Gamma criteria were increasing the difference in mean %GP between photon energy.

Further studies on other diagnosis and other treatment technique can provide better understanding of the results obtained in this present study.

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Conflict of Interest

The authors declare that they have no conflicts of interest. The authors alone are responsible for the content and writing of the paper. No Financial Aid or Grant is received from any Institution for conducting this study.

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