

# Patient Specific Quality Assurance of Volumetric Modulated Arc Therapy (VMAT): Portal Dosimetry Compared with ArcCheck Phantom

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## INTRODUCTION

Due to the complexity of the Volumetric Modulated Arc Therapy (VMAT) dose distribution, implementation of pre-treatment verification is an essential procedure in clinical practice to ensure that the accuracy radiation dose is delivered to the patient as planned [1]. One of the devices intended and designed for VMAT QA is ArcCheck. The detector characteristic and its ability of VMAT QA has been reported by a number of authors [2-5]. Another system for VMAT QA is portal dosimetry system (PDs) which is widely used because of its resolution, large detector density, large detector surface and friendly for user [6-7].

Gamma evaluation is a common quantitative technique for assessment the agreement between measured dose and the planned dose by using gamma index ( $\gamma$ ). AAPM Task Group 119 suggested the acceptance criteria of 3%/3mm (DD/DTA). However, number of studies have discussed the acceptance of gamma criteria by reducing the criteria to 2%/2mm or 1% /1mm. They found the higher sensitivity of error detection [8-9].

## AIM

To compare the result of Portal Dosimetry system with ArcCheck for delivery quality assurance of head and neck and prostate VMAT with various gamma criteria evaluation.

## METHOD

The Varian amorphous silicon (aSi) Portal Imaging Devices was used for portal dosimetry. A 3D array ArcCheck cylindrical was used for phantom studies. Eclipse-TPS and portal dose prediction software was used for planar dose calculations. The 30 VMAT patient plans of head and neck site and prostate site from department of radiotherapy, Lopburi Cancer Hospital were created for verification plan on two different QA system PDs and ArcCheck. Thirty plans each with 2 or 3 arcs were delivered on the EPIDs of the Varian Linac ix and on ArcCheck cylindrical phantom, respectively. The measured planar dose matrices were compared with planned dose and were analysed using global gamma evaluation with the criteria (DD/DTA) of 3%/3mm, 3%/2mm and 2%/2mm, respectively. The evaluation protocol is shown in Table 1.

## RESULTS

Table 2 shows the comparison of gamma pass rate using various gamma evaluation criteria. All head and neck plans measured by PDs and ArcCheck had the average gamma passing rate using 3%/3mm of  $97.91\% \pm 0.93$  and  $97.81\% \pm 0.81$ , respectively. When using 3%/2mm and 2%/2mm, the average passing rate measured by PD was  $95.65\% \pm 0.83$  and  $76.48 \pm 2.55$  while the results measured by ArcCheck was  $96.63\% \pm 0.77$  and  $79.77 \pm 2$ , respectively. There were no significant differences in the ArcCheck and PD planar dose measurements between different TPS dose calculation algorithms (p value = 0.760). The result showed significant difference between measured dose for both dosimetry system and planned dose when decrease the criteria to 3%/2mm (p value = 0.0025) and 2%/2mm (p value = 0.0006).

All prostate plans measured by PDs and ArcCheck when 3%/3mm criteria was applied has the average gamma passing rate of  $99.10\% \pm 0.86$  and  $99.56\% \pm 0.47$ , respectively. The average gamma rate when using 3%/2mm was  $98.11\% \pm 1.02$  for PDs and  $98.67\% \pm 0.90$  for ArcCheck. The passing rate decreased to  $97.05\% \pm 0.82$  for PD and  $97.46\% \pm 0.68$  for ArcCheck when 2%/2mm was applied. The prostate cases illustrated no significant difference for all gamma criteria with the p value greater than 0.05.

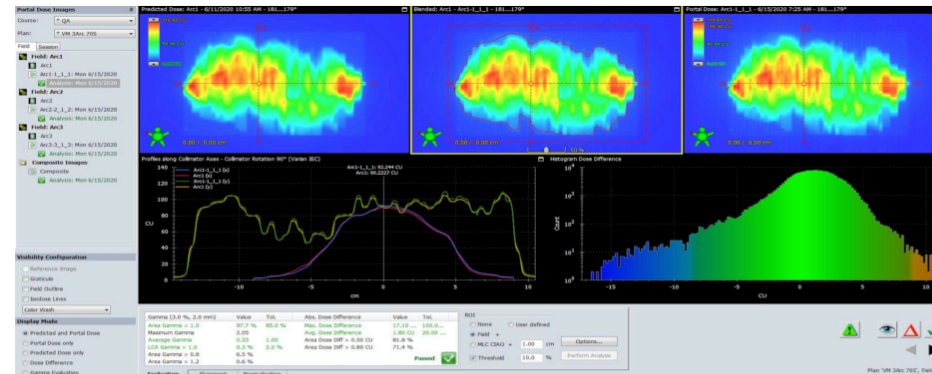


Figure 1 Comparison of PD calculated (top left) and EPID measured planar dose distribution (top right) showing gamma analysis results (bottom) and line profile agreement (top middle).

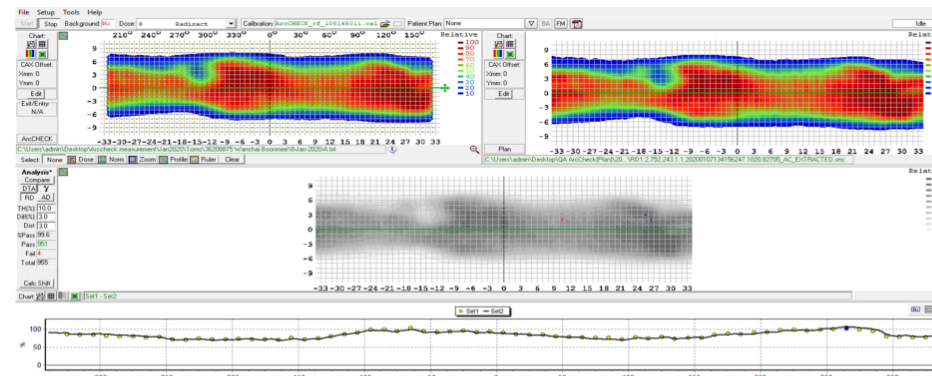


Figure 2 Comparison of TPS calculated (top right) and ArcCheck measured planar dose distribution (top left) showing gamma analysis results and line profile agreement (bottom).

Table 2: The comparison between the gamma passing rates of portal dosimetry and those of ArcCheck measurements.

Tumor Site	$\gamma$ Criteria	PDs	ArcCheck	P
Head and Neck	3%/3mm	$97.90 \pm 0.93$ ( 96.60 ~ 99.90 )	$97.80 \pm 0.80$ ( 96.90 ~ 99.00 )	0.7600
	3%/2mm	$95.65 \pm 0.83$ (94.00 ~ 97.00 )	$96.62 \pm 0.77$ ( 95.2 ~ 97.50 )	0.0025
	2%/2mm	$76.46 \pm 2.55$ (69.90 ~ 79.40)	$79.77 \pm 2.11$ (73.70 ~ 82.50)	0.0006
Prostate	3%/3mm	$99.10 \pm 0.86$ ( 98.00 ~ 100.00 )	$99.56 \pm 0.47$ ( 98.80 ~ 100.00 )	0.0800
	3%/2mm	$98.11 \pm 1.02$ ( 97.00 ~ 99.90 )	$98.67 \pm 0.90$ (97.20 ~ 100.00 )	0.1300
	2%/2mm	$97.05 \pm 0.81$ (95.70 ~ 98.40)	$97.46 \pm 0.68$ (96.00 ~ 98.70)	0.1508

## CONCLUSIONS

The gamma passing rates of portal dosimetry were comparable to those of the ArcCheck and PDs measurements for all gamma criteria. There distinctive differences were observed when the stringent gamma criteria were applied. Therefore, both dosimeter system can be used as an alternative to each other for patient- specific QA of both VMAT with suitable gamma criteria to ensure clinically acceptable dose errors.

## CONTACT INFORMATION

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