VIRTUAL QA & DOSIMETRY SYMPOSIUM

CALA Poster Competition

PSQA investigation when acceptance criteria fails

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Introduction

Patient-Specific QA (PSQA) is designed to check and verify the delivered dose in radiation treatments. It is strongly recommended to establish tolerance and action limits for a robust IMRT QA Verification process [1]. On the other hand, the treatment process should be monitored and thoroughly investigated if those limits are exceeded to identify deviation reasons, increase the knowledge of the system, and evaluate potential clinical consequences. Among probable causes, we can highlight the calculation model, the detection system, or the delivery system.

Objective

To perform a retrospective study of cases with gamma passing rate lower than tolerance limits, evaluating multiple parameters, and identifying possible causes..

Method & Materials

The CEMENER foundation established its PSQA methodology based on a detailed previous study [2]. It institutes the EPID as the first barrier, performing a second control with ArcCheck® and 3DVH® when QA does not satisfy the criteria (Fig. 1). During 12 months, 149 PSQA (86 VMAT and 63 IMRT) were executed following the methodology proposed, 29 of it exceeded the Tolerance Limit (TL), and 1 exceeded the Action Limit (AL). For the analysis, a Developed Software (DS) evaluates, in each control point, the distance between opposite leaves on the Multileaf Collimator. It returns a Histogram distance for each field and is applied to recognize complex plan designs and deliveries.

According to their source parameters were grouped derived from:

- Treatment plan
- Portal Dosimetry,
- Developed Software,
- SNC-Patient and the 3DVH®.

Table 1 summarizes the main parameters obtained from each

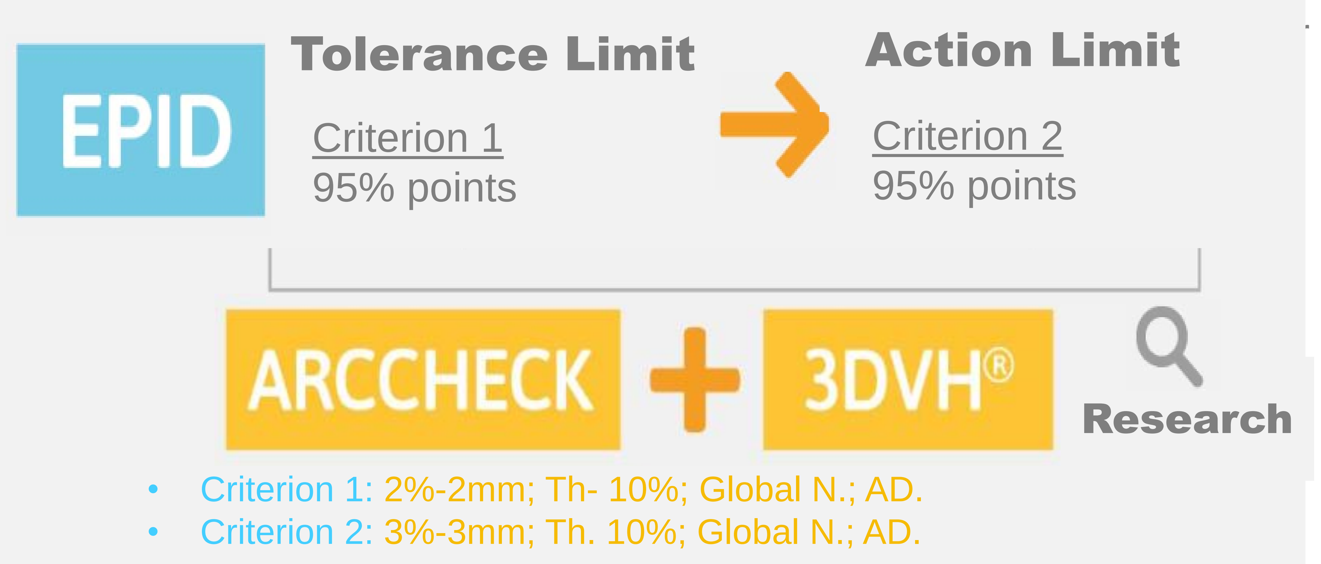

Fig. 1: PSQA Methodology [2].

Source		Parameters
Treatment Plan	i -	Treatment Machine
	ii-	Date
	iii-	Technique (VMAT or IMRT)
	iv -	Jaw Tracking
Portal Dosimetry (EPID)	v -	Field identification & Zone of Failure (ZF)
	vi -	Counting Units (CU) in ZF
	vii -	Split Fields Fusion
	viii -	Qualitative Analysis of MLC & ZF
Developed Software	ix -	Leaf Distance <1cm
SNC-Patient (ArcCheck®)	x -	Gamma Index
3DVH® (ArcCheck ®)	xi -	% points - Criterion 1 on Volume
	xii -	% points - Criterion 1 on PTV
	xiii -	% points - Criterion 1 on OAR
	xiv -	DVH Analysis
	xv -	Slice-by-slice Analysis

Table 1: Evaluated Parameters and their source

Results & Discussion

Table 2 summarizes the errors found, the parameter used to identify it, the number of cases the error appears, and the possible source.

→ In 3 cases TL was beaten due to a low resolution of the calculated data.

→ In 4 situations an EPID miscalibration was identified by observing the mean dose difference, the date, and qualitative analysis.

→ 6 complex plan designs were identified by studying the distance between opposite leaves (Fig. 2), in combination with a qualitative analysis.

→ In IMRT, 12 large fields with carriage groups retained on one field carriage group presented a Failure Zone (FZ). This FZ is located near the split zone with a low Counting Unit (CU).

→ In 9 VMATs FZ corresponds to regions barely blocked by leaves, however, due to the rotating technique it doesn't represent a clinical impact when the 3DVH® is observed.

→ Trough the 3DVH® analysis (Fig. 3), minor clinical differences manifested in 7 situations, and one of them with appreciable consequences. Those situations are transversal the other cases and are used to evaluate the possible clinical impact

The results showed the importance of considering the complexity of the plan design. It is also necessary to review the calculation model for MLC and small fields conditions.

The use of the ArcCheck® system with 3DVH® allows the conversion of the measured data to 3D absolute dose distribution in patients. It is possible to evaluate the Dose Volume Histogram (DVH), determine the 3D gamma-index (for each volume separately), and identify points of under or overdose, among other results.

Error	Parameter	Occurrence	Possible Source
Plan Resolution	viii	3 (10%)	Calculation Model
EPID descalibrado	i – ii – viii – x	4 (14%)	Measurement Method
Complex Plan Design	viii – ix	6 (20%)	Planification /Calculation Model/Delivery
Split Fields Fusion	v – vi – vii – viii – xiv	12 (39%)	Calculation Model/EPID Model /Delivery
VMAT superposition Zone	v – vi - viii – xiv	9 (31%)	Calculation Model/Delivery
Possible Clinical Consequences	xi – xii – xiii – xiv - xv	7 (24%)	Calculation Model/Delivery

Tabla 2: Errors, parameters used to identify it, occurrence and y possible source.

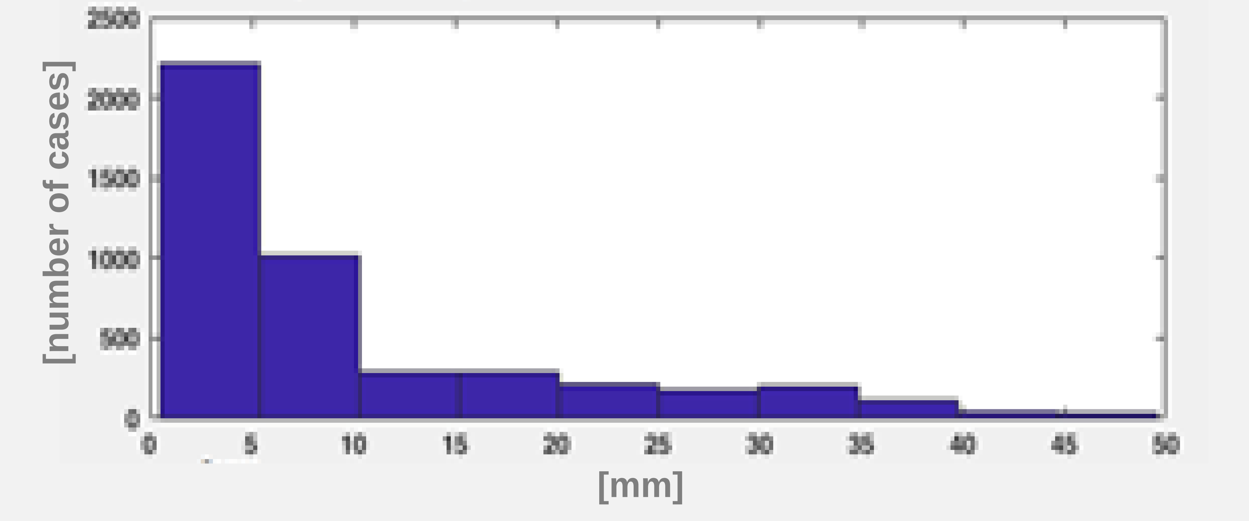

Fig. 2: histogram of distance between leaves per field.

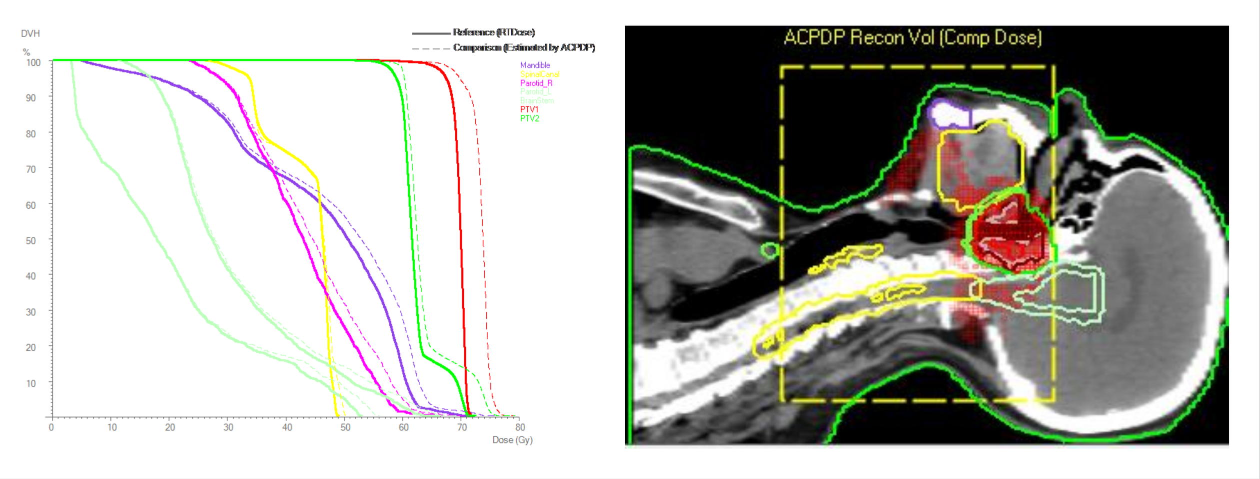

Fig. 3: 3DVH® results. Dose Volume Histogram (left). Sagittal plane (right).

Conclusions

Based on the results, the calculation model will be reviewed, and a tool to assess plan complexity will be designed. It is necessary to continue with the analysis and to establish an investigation methodology.

Investigation of failed cases allows recognizing system alterations. The combination of measurement systems and the proper choice of evaluated parameters increases the possibility of recognizing the source of the failure, and the fidelity of the PSQA. Gamma tests could underestimate clinical consequences but the three-dimensional estimation tools represent a powerful way to overcome this situation.

References

1 - 2018 AAPM's TG-218 recommendations "Tolerance limits and methodologies for IMRT measurement-based verification QA".

2 - F. Bregains; N. Larragueta; "Implementación de un programa de Control de Calidad Paciente Específico". CALA Poster Competition.