

An evaluation of the stability of image quality parameters of Varian on-board imaging (OBI) and EPID imaging systems

Dennis Nichols Stanley, Niko Papanikolaou, Alonso N Gutierrez

University of Texas Health Science Center San Antonio, San Antonio, TX, USA.

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Abstract

Purpose: Quality assurance of the image quality for image guided localization systems is crucial to ensure accurate visualization and localization of target volumes. In this study, the stability of selected image parameters was assessed and evaluated for CBCT mode, planar radiographic kV mode and the radiographic MV EPID mode.

Methods and Materials: The CATPHAN, QckV-1 and QC-3 phantoms were used to evaluate the image quality parameters. The planar radiographic images were analyzed in PIPSPRO™ with spatial resolution (f30, f40, f50) being recorded. For OBI CBCT, High quality head Full-Fan acquisition and Pelvis Half-Fan acquisition modes were evaluated for Uniformity, Noise, Spatial Resolution, HU constancy and geometric distortion. Dose and kVp for the OBI were recorded using the Unfors RaySafe Xi system with the R/F High Detector for planar kV and the CT detector for CBCT. Dose for the MV EPID was recorded using a PTW975 Semiflex Ion Chamber, weblin electrometer and 1cm SolidWater™.

Results: For each metric, values were normalized to the mean and the standard deviations were recorded. **Table 1** shows the standard deviation for all results. Using this, tolerances can be reported as a warning threshold of 1σ and

an action threshold of 2σ . **Table 2** shows the warning and action tolerances for the planar radiographic modalities while **Table 3 and 4** show tolerance levels for the Full-Fan and Half-Fan, respectively.

Conclusion: A study was performed to assess the stability of the basic image quality parameters recommended by TG-142 for the Varian OBI and EPID Imaging systems. The two systems show consistent imaging and dosimetric properties over the evaluated time frame.

Presenting author: Dennis Nichols Stanley; University of Texas Health Science Center San Antonio, San Antonio, TX, USA.

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Table 1: Normalized standard deviations for all evaluated metrics							
Planar Radiographic							
	kV			MV			
f_{30}	0.015	kVp	0.010	f_{30}	0.006	Dose	0.005
f_{40}	0.008	Dose	0.010	f_{40}	0.009		
f_{50}	0.004			f_{50}	0.018		
CBCT							
Full-Fan CBCT							
Spatial Resolution	HU constancy		Geometric Distortion		Dosimetric		
f_{30}	0.087	Lung(PMP)	0.023	AP	0.005	Dose	
f_{40}	0.086	Water(poly)	0.065	LAT	0.005	Center	0.004
f_{50}	0.074	Bone(Derlin)	0.010	Slice thickness mean	0.056	Periphery	0.004
Uniformity	0.061	Noise	0.063				
Half-Fan CBCT							
Spatial Resolution	HU constancy		Geometric Distortion		Dosimetric		
f_{30}	0.110	Lung(PMP)	0.038	AP	0.006	Dose	
f_{40}	0.116	Water(Poly)	0.058	LAT	0.005	Center	0.007
f_{50}	0.173	Bone(Derlin)	0.020	Slice thickness mean	0.059	Periphery	0.003
Uniformity	0.090	Noise	0.079				

Table 2: Thresholds for the Planar radiographic modalities					
	kV		MV		
	Warning	Action	Warning	Warning	Action
f_{30}	2%	4%	f_{30}	2%	4%
f_{40}	1%	3%	f_{40}	1%	3%
f_{50}	1%	3%	f_{50}	1%	3%
Dose	1%	2%	Dose	1%	2%
kVp	1%	2%			
<i>Sample size of 30 measurements</i>					

Table 3: Image Quality Thresholds for the Full-Fan CBCT		
Metric	Warning	Action
Uniformity	6%	12%
Noise	6%	12%
Spatial Resolution		
f_{30}	9%	18%
f_{40}	9%	18%
f_{50}	8%	16%
HU Constancy		
Lung (PMP)	3%	6%
Water (Poly)	6%	12%
Bone (Derlin)	1%	2%
Geometrical Distortion		
AP	1%	2%
LAT	1%	2%
Slice thickness mean	6%	12%
Dose		
Center	1%	2%
Periphery	1%	2%
<i>Sample size of 25 measurements</i>		

Table 4: Image Quality Thresholds for the Half-Fan CBCT		
Metric	Warning	Action
Uniformity	9%	17%
Noise	8%	16%
Spatial Resolution		
f_{30}	10%	20%
f_{40}	11%	22%
f_{50}	17%	34%
HU Constancy		
Lung (PMP)	4%	8%
Water (Poly)	6%	12%
Bone (Derlin)	2%	4%
Geometrical Distortion		
AP	1%	2%
LAT	1%	2%
Slice thickness mean	6%	12%
Dose		
Center	1%	2%
Periphery	1%	2%
<i>Sample size of 25 measurements</i>		