CT Patient Dose Monitoring Using Radiochromic Dosimeters

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Introduction

With the increased concern of radiation exposure received by patients undergoing medical exams, especially computerized tomography (CT), finding a quick and economical method to estimate patient dose has become a critical issue. Radiochromic film requires no chemical processing and can be read in visible light. Improvements in the stability and dynamic range of radiochromic film have led to its use in a wide variety of medical physics quality assurance applications and in estimating skin doses from various procedures.

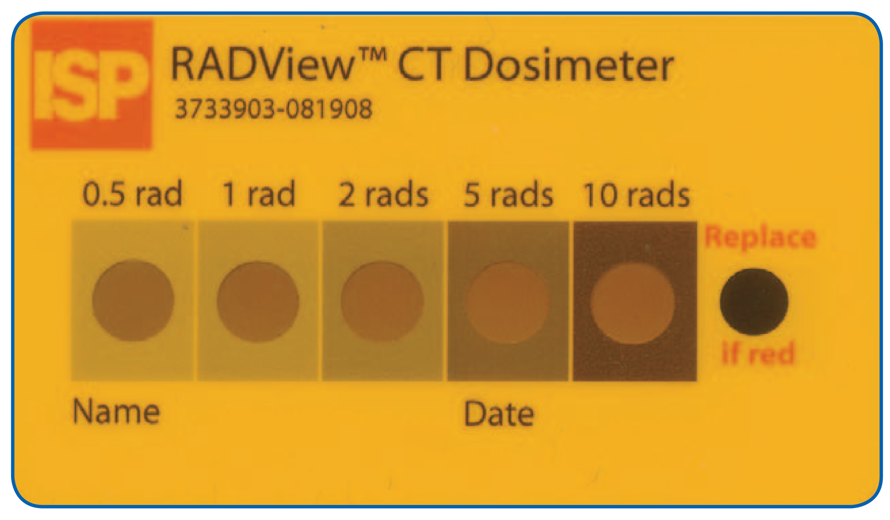
Objectives

Our facility was interested in evaluating a new radiochromic film dosimeter developed specifically for patients undergoing CT scans. Accuracy of the radiochromic dosimeters were compared with a calibrated scanner and LiF100 TLD chipstrate dosimeters.

Background

A new radiochromic film dosimeter, RADViewTM CT, developed by International Specialty Products, was used to measure exposure from commonly ordered CT scans at our facility. The dosimeter is a flexible card with five circular windows through which the active element is viewed. Printed color patches surrounding each window provide a reference for estimating the exposure. The color patches are printed to match doses of approximately 0.5, 1, 2, 5 and 10 rad. After exposure, the color of the active element in the window is visually compared to the reference colors and the dose is estimated by interpolation.

Figure 1



The CT studies chosen for this evaluation were of the head, abdomen, brain, pelvis, liver (4 phase), and excretory urograph (exu). Five dosimeters were used for each type of study and placed directly on top of the patient in the area of interest. To validate the dose observed on the RADViewTM CT card, two LiF100 TLD chipstrate dosimeters were placed on each side of the card.

After each CT procedure, the dosimeters were independently read by four medical physicists at our facility. In addition to visual dose estimation, the darkening on the RADViewTM CT dosimeters was measured with an EPSON 10000XL photo scanner calibrated to reference dose film strips.

Results

The average visual assessment of dose for the five dosimeters used in each CT procedure ranged from -15% (under estimate) to 28% (over estimate) when compared to the calibrated scanner results for a head CT, -16% to 5% for an abdominal CT, 11% to 32% for a pelvic CT, 4% to 23% for a liver (4 phase) CT, and, -17% to 4% for an exu CT. Results could not be obtained for the brain perfusion CT since they exceeded the upper dose range of the dosimeter film used in this study. When calibrated scanner results were compared with raw TLD data, good agreement, within 25%, was obtained for all dosimeters within the dose range of the radiochromic film.

Conclusion

The radiochromic film dosimeters used in this study provided a good first approximation of skin dose to patients undergoing five of the most commonly ordered CT procedures at our institution. The doses recorded by the exposed dosimeters were quickly estimated with good accuracy compared to quantitative measurements. To be most clinically useful, it would be helpful to extend the sensitivity range of the tested dosimeter to include higher doses typical for CT perfusion studies.

Table 1

CT Scan	DLP, mGy-cm	kVp	mAs	CTDI vol, mGy	Reader Average, rad	Scanner, rad	% Diff	TLD Left	TLD Right
Head - regular	971	120	570	69.4	5.4	4.2	28.0	3.2	3.6
Head - regular	1110	120	570	69.4	5.9	6.9	-15.0	5.7	5.5
Head - regular	1041	120	570	69.4	4.4	4.8	-8.0	4.1	4.0
Head - regular	1110	120	570	69.4	5.9	5.6	5.0	5.9	4.7
Head - regular	1075	120	570	69.4	5.8	4.9	18.0	4.1	4.2
Abd - regular	1180	120	328	22.2	2.0	1.9	5.0	2.0	1.9
Abd - regular	602	120	213	14.4	2.3	2.2	4.5	2.0	2.1
Abd - regular	987	120	265	17.9	2.5	2.5	0.0	2.5	2.0
Abd - regular	943	120	296	20.0	2.1	2.5	-16.0	2.6	1.7
Abd - regular	1177	120	314	21.2	2.0	2.3	-13.0	2.1	2.9
CT perfusion	6550	80	240	523.9	> 10	22.7	N/A	33.4	30.7
CT perfusion	6238	80	240	483.2	> 10	22.8	N/A	32.4	28.4
CT perfusion	5546	80	240	405.8	> 10	21.3	N/A	26.8	33.5
CT perfusion	4368	80	240	337.6	> 10	18.5	N/A	25.3	23.1
CT perfusion	4362	80	240	337.2	> 10	22.0	N/A	23.6	24.0
Pelvis	1180	120	328	22.2	2.2	1.9	15.0	2.0	1.9
Pelvis	602	120	213	14.4	3.3	3.0	11.0	3.0	3.1
Pelvis	987	120	265	17.9	4.0	3.0	32.0	3.0	2.4
Pelvis	943	120	296	20.0	2.8	2.5	11.0	2.2	2.5
Pelvis	1177	120	314	21.2	0.9	0.8	13.0	1.2	0.5
4 phase liver	2613	120	286	215.4	10.0	8.2	22.0	6.6	6.5
4 phase liver	1879	120	209	156.2	10.5	10.1	4.0	7.9	9.2
4 phase liver	1674	120	174	215.3	7.9	6.4	23.0	5.2	5.2
4 phase liver	2909	120	266	310.1	7.3	6.9	6.0	6.9	6.4
4 phase liver	2552	120	284	166.8	10.5	8.8	19.0	8.2	9.0
EXU	3100	120	186	94.2	10.5	12.7	-17.0	10.1	10.5
EXU	3151	120	275	114.8	10.0	10.4	-4.0	9.6	9.0
EXU	3006	120	218	103.5	10.1	10.8	-6.0	10.0	11.3
EXU	2531	120	234	105.0	7.5	7.2	4.0	8.1	7.5
EXU	2282	120	209	85.8	9.3	8.9	4.0	8.5	8.5