Cyberknife treatment plan MU and Dose verification using IMSureQA

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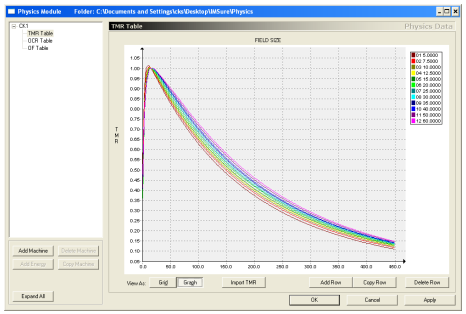
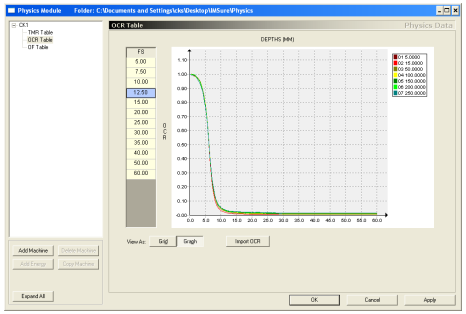
Introduction

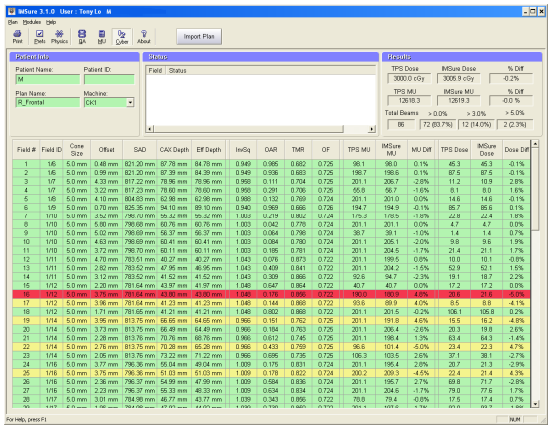
Cyberknife Treatment plans generated from MultiPlan 2.1.0 system are checked by commercial software IMSureQA 3.1.0 (Standard Imaging, Inc.) MultiPlan uses Ray-Tracing as the default dose calculation mode with beam parameters: OF (output factor), TPR (tissue phantom ratio) and OCR (off center ratio). These beam parameters are loaded into IMSureQA through the Physics module. The IMSureQA program checks total dose to a reference point defined during planning. Beam parameters and dose contribution to the reference point from individual beam are stored in Beam List and total reference dose is stored in Plan Overview. IMSureQA calculates dose from individual beam and sum as the total dose, which is compared with the reference dose from Plan Overview. Over 200 plans have been checked using IMSureQA for 2 Cyberknifes since Feb 2008. Results from recent plans are summarized.

Beam Data





Sample IMSureQA Result



Variation Between Multiplan and IMSureQA

Case	Cone	Total dose difference %	% of beams >3%	% of beams >5%	Target size and shape
iso-1	7.5	0	0	0	
iso-2	12.5	0	0	0	
iso-3	15	0.1	0	0	
6D-1	10	-0.2	2.9	0	
6D-2	16	-0.1	5.8	0.7	
6D-3	20	-0.1	14.7	14.7	large
6D-4	15	-0.1	4.9	2.7	long
6D-5	15	-0.1	15.3	14.7	long
6D-6	10	0	3	0.6	
6D-7	20	0.1	7.4	4	
6D-8	7.5	0.1	8.7	0	
6D-9	12.5	0.2	5.8	0	
6D-10	7.5	0.2	0	0	
6D-11	10	0.2	6.7	0	
6D-12	15	0.2	7.3	0.7	
6D-13	7.5	0.3	8.8	1.5	
6D-14	12.5	0.3	4.4	0	
6D-15	10	0.3	9	1.2	
6D-16	10	0.3	2.7	0	
6D-17	10	0.4	6	1.2	
6D-18	15	0.4	8.8	1.9	
6D-19	5	0.4	11.3	0.7	
6D-20	5	0.4	3.3	0	
Xsight-1	12.5	0.4	10.2	4.1	large
Xsight-2	10	0.7	12	9.3	long
Xsight-3	7.5	1	9.8	0.8	
Xsight-4	12.5, 20	1	9.9	6.8	irregular
Xsight-5	25	1	12.8	5	irregular
Xsight-6	15	1.1	6.7	1.9	long
Xsight-7	20	1.1	6.5	4.3	long
Xsight-8	20	1.1	9.4	6	irregular
Xsight-9	15, 35	1.2	6.7	2.4	irregular
Xsight-10	25	1.2	4.7	0	

Variation Summary

	Total dose difference %	% of beams >3%	% of beams >5%	
6D only	0.2 (0.2)	7 (4)	2 (4)	average (std dev)
Xsight only	1.0 (0.2)	9 (3)	4 (3)	Average (std dev)
Overall	0.4 (0.4)	7 (4)	3 (4)	average (std dev)

Results

Average deviation of total dose between MultiPlan and IMSureQA is 0.4%. 7% of all beams are > 3% dose difference and 3% of all beams are > 5% dose difference. Xsight tracking plans average 1% total dose deviation, 9% beams > 3% dose difference and 4% beams > 5% dose difference. Beam with large dose difference is due to dose calculation point at large off axis distance and/or far away from calibration distance of 80 cm. Simple isocentric plans have the smallest deviation while complex plans for irregular shaped target or multiple targets had the biggest deviation.

Conclusions

IMSureQA consistently calculates MU / dose with under 1% deviation from MultiPlan. Large individual beam dose variation comes from large off axis distance which contributes very little dose to the reference point therefore the total dose deviation is quite small. IMSureQA can replace hand calculation for MU dose verification purpose.

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