Reflexion Arc Therapy Vs Varian VMAT
A Quality Metrics Comparison for Lung SBRT

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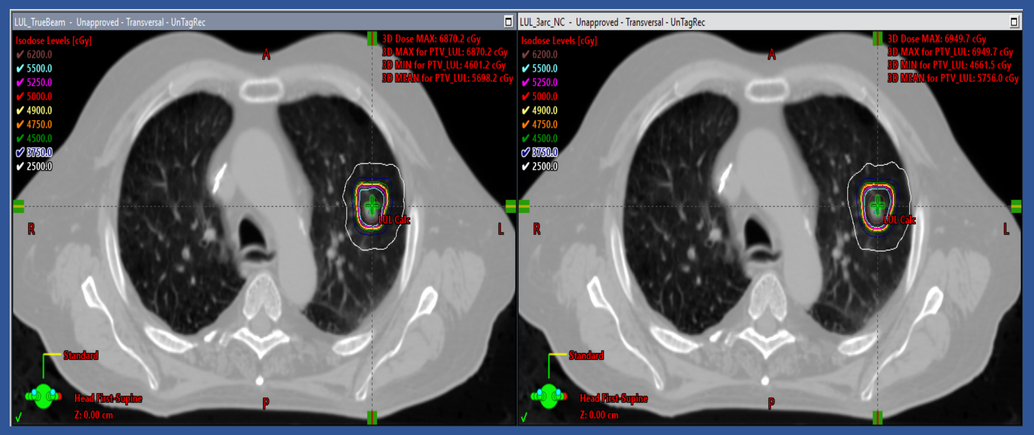
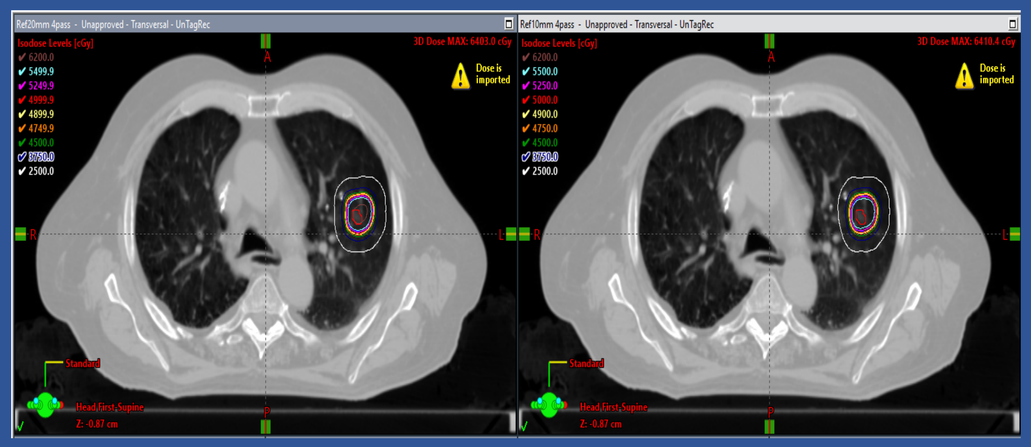
Objective: The purpose of this study was to perform a dosimetric comparison of SBRT Quality Metrics for lung plans calculated on Reflexion and Eclipse TPS utilizing full arc, partial arc, and non-coplanar techniques.

Method: 16 lung cancer patients treated without gating were retrospectively planned for SBRT using both Reflexion (RefleXion Medical, Inc.) and Varian TPSs (Varian Medical systems). Patients were simulated using a (4DCT) on a Philips Big Bore 16 slice CT scanner. These patients were all assessed for minimum and maximum tumor motion and were treated without gating. Then all ten phases of the 4DCT were evaluated and the generation of a 0%,50% or 60%, and MIP data set was created to accurately distinguish the GTV. An ITV was then created by expanding the GTV by 5mm. The PTV was then added by expanding the ITV by 5mm. The average size of all PTVs was 20.8cc.
Eclipse VMAT patients were planned with 2 techniques: half arc VMAT, and half arc VMAT with 3 non-coplanar arc beam arrangements all using 10MV FFF. Eclipse VMAT plans were generated with 2 half arcs with gantry angles of 0-180 deg CW and CCW for Lt sided lesions, and 180-0 deg CCW and CW for Rt sided lesions. The non-coplanar plans were planned using one arc as a half arc at 0 deg couch angle. A second partial 50 deg arc at a 10 deg or 350 deg couch angle depending on clearance. A third beam was added with a partial arc of 50 degrees to 90 degrees with a 10 deg couch angle opposite of the previous 10 or 350 deg couch position. For Reflexion, 6MV FFF four pass, full arc plans were generated, one with 20mm jaw settings and one with 10mm jaw settings for each patient. The treatment doses ranged from 5000cGy in 5 fractions to 5400cGy in 3 fractions. A total of 64 plans were compared using the following metrics: Conformality Index (CI100), Gradient Index (CI50) , High Dose Spillage, Intermediate Dose Spillage (D2cm), and Skin maximum doses. Lung metrics were also compared using V20, MVS1250cGy, and MVS1350cGy indexes. These plans were optimized using similar optimization parameters to achieve the same minimum dose coverage as the coplanar and non coplanar beam plans. All plans were normalized to achieve the dose coverage of at least V100 > 95%. This criteria was derived from the RTOG 1021,0813, and 0915 lung protocols.

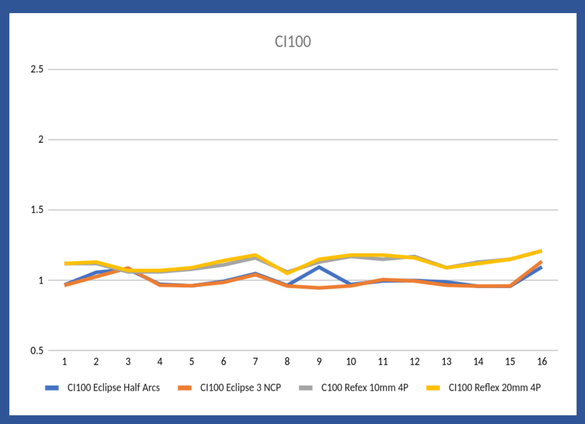
Results: Reflexion SBRT plans showed minimal changes in (CI100) with an avg STDEV .0759%, (CI50) showed differences that were slightly higher in Reflexion with an avg STDEV 0.3480%, High Dose Spillage was as much as 10.0% higher than the Eclipse values with respect to the size of PTV with an AVG STDEV of 0.0151%, (D2cm) indexes showed minimal differences between all plans with and AVG STDEV of 1.1095%. Skin doses were noted to be lower in Reflexion due to the full arc technique used. Lung criteria were also comparable and within a few percent to each other with all techniques and modalities.
Lung doses were evaluated as per RTOG criteria. These results fluctuate only slightly, depending on the location of the lesion inside the lung. Lung doses with lesions that were in the periphery near the chest wall had lower doses than lesions that were centered in the ipsilateral lung. This was notice throughout all techniques. V20, MVS1250cGy, MVS1350cGy, lung doses were evaluated in all patients and showed minimal differences between all plans.

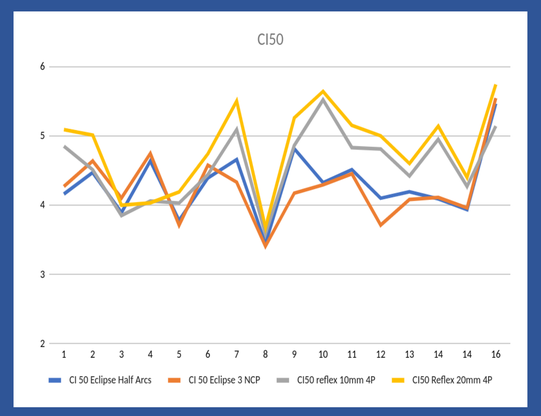
Patient	CI100 Eclipse Half Arcs	CI100 Eclipse 3 NCP	C100 Refex 10mm 4P	CI100 Reflex 20mm 4P	% STDEV
1	0.968	0.965	1.12	1.12	0.088631
2	1.058	1.027	1.12	1.13	0.049452
3	1.079	1.088	1.06	1.07	0.012010
4	0.972	0.966	1.06	1.07	0.055629
5	0.962	0.963	1.08	1.09	0.070844
6	0.993	0.986	1.11	1.14	0.079235
7	1.048	1.041	1.16	1.18	0.072972
8	0.965	0.961	1.06	1.05	0.053297
9	1.094	0.947	1.13	1.15	0.091805
10	0.971	0.962	1.17	1.18	0.120502
11	0.996	1.006	1.15	1.18	0.095561
12	0.999	0.996	1.17	1.16	0.096800
13	0.989	0.966	1.09	1.09	0.065627
14	0.958	0.959	1.13	1.12	0.096216
15	0.958	0.961	1.15	1.15	0.109992
16	1.095	1.135	1.21	1.21	0.057227
				AVG STDE	0.075987





Patient	CI 50 Eclipse Half Arcs	CI 50 Eclipse 3 NCP	CI50 reflex 10mm 4P	CI50 Reflex 20mm 4P	% STDEV
1	4.16	4.27	4.85	5.09	0.44902672
2	4.47	4.637	4.51	5.01	0.24602625
3	3.893	4.104	3.85	4	0.11388993
4	4.636	4.746	4.06	4.033	0.37496433
5	3.781	3.71	4.03	4.19	0.22224667
6	4.392	4.577	4.44	4.74	0.1562506
7	4.658	4.332	5.09	5.5	0.50898199
8	3.445	3.409	3.58	3.68	0.12497599
9	4.814	4.173	4.86	5.26	0.44957859
10	4.324	4.294	5.52	5.64	0.73554764
11	4.511	4.453	4.83	5.15	0.32194512
12	4.1	3.713	4.81	5	0.60275388
13	4.192	4.082	4.42	4.6	0.23193318
14	4.091	4.111	4.95	5.14	0.55057121
14	3.936	3.961	4.27	4.4	0.22959729
16	5.465	5.544	5.14	5.74	0.24985379
				AVG STDE	0.34800895





Conclusion

In Conclusion we can say that both the Reflexion TPS and Varian TPS using all three techniques were able to meet all of the RTOG plan quality metrics.
With regards to plan quality, using the Reflexion TPS can produce plans equal to or comparable to Varian VMAT coplanar and non-coplanar techniques. Conformality indexes for plans generated with non-coplanar beams showed very little improvement over plans generated with coplanar beams in Eclipse or Reflexion. Slightly higher differences were seen with gradient indexes along with the high dose and intermediate dose spillage results in the Reflexion plans.