

APBI Using Respiratory Gated IMRT - Review of First 24 Patients

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ABSTRACT:

Intensity Modulated Radiation Therapy (IMRT) with respiratory gating is used to deliver Accelerated Partial Breast Irradiation (APBI) in selected patients with early breast cancer following breast conserving surgery. APBI can be delivered using conformal external beam radiation therapy or brachytherapy, including Mammosite™ and interstitial implantation. IMRT has not been widely used due to the intra-fraction breast motion associated with the respiratory cycle. However, respiratory gating provides a useful tool to minimize the impact of breast motion relative to the MLC segments. IMRT enables delivery of a highly conformal dose to the surgical cavity.

MATERIALS & METHODS:

24 postmenopausal women with Stage I and II breast cancer elected to receive APBI using IMRT with respiratory gating following lumpectomy. Patients were enrolled in an IRB approved protocol to evaluate tumor bed irradiation after lumpectomy. 13 out of 24 patients had right-sided breast tumors while 11 had tumors located in the left breast. Patients were treated in the supine position, immobilized on a breast board with both arms up. Beam arrangements for the right and left breast lesions are shown in Figures 1 and 2 respectively. Respiratory gating was used at the time of simulation and treatment. Only the exhalation part of the cycle was used. This reduced the breast excursion of 8-10 mm to about 2 mm in the AP direction. A verification CT was repeated in 12 out of the 24 patients towards the end of the course of treatment to evaluate reproducibility. EPID was used for set up verification before each treatment delivery. In all patients the lumpectomy cavity was clearly defined on CT scans. 12 patients had surgical clips outlining the surgical cavity. The CTV consisted of the lumpectomy cavity plus a 10-15 mm margin. No further margin was added to define the PTV. The CTV was treated BID, 380 cGy per fraction for 5 days to a total dose of 3800 cGy. Figures 3 and 4 show typical dose distributions.

RESULTS:

The median age of the patients was 70. The median CTV treated was 58 cm³. In this group of patients, the CTV received at least 95% of the prescribed dose. Dose to the skin and chest wall musculature was limited to 30 Gy. The mean dose to the CTV was 3885 cGy. Twelve out of 24 patients received a dose greater than 114 cGy (3%) to the contra lateral breast while the dose to the heart was greater than 190 cGy (5%) in 3 of 24 patients. Of these three patients, two had left breast tumors while one patient had a right breast tumor. Other than the contra lateral breast and heart, results show that IMRT-based APBI objectives were achieved when compared with the currently accruing NSABP/RTOG study, while CTV dose conformity was excellent. Acute toxicity was limited to Grade I erythema (13 out of 24 patients), Grade I myositis (5 out of 24 patients) and Grade I hyperpigmentation (8 out of 24 patients). With a median follow up of 19 months (range 9-32 months), only 1 patient developed late toxicity (grade II telangiectasia) and no patient developed local recurrence. No skin changes greater than Grade I erythema were noted during treatment. Cosmetic results were excellent in 22 patients, good in 2 patients and fair in one patient.

CONCLUSION:

1. Clinical and dosimetric results are similar to previously published techniques to deliver APBI.
2. Respiratory gating and EPID provide a reproducible patient set up for APBI.
3. Maximum radiation dose to the rest of the ipsilateral breast is less when compared to 3D conformal treatment and more homogenous than the other APBI techniques (Figure. 6).
4. With short term follow up this approach is well tolerated, with excellent cosmetic results in the majority of patients. See pictures in Figures 7 and 8.

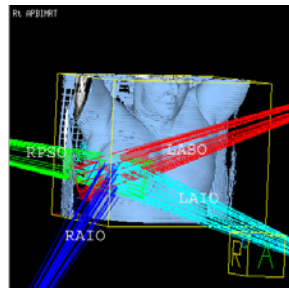


Figure 1. A typical 4-field non-coplanar beam arrangement for a Rt. sided APBI. The beams, arranged clockwise from the left are as follows: RAIO, RPSO, LASO, and LAIO.

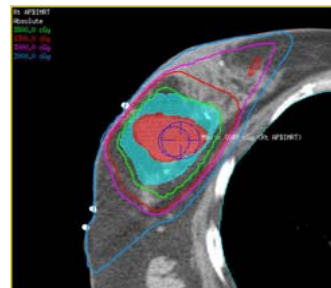


Figure 3. A typical isodose distribution for a Rt. sided APBI. The 3800 cGy isodose line (green) encompasses the CTV (cyan). The skin and chestwall receive only 3000 cGy (pink isodose line).

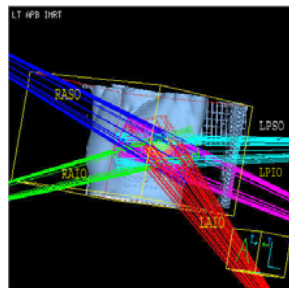


Figure 2. A typical 5-field non-coplanar beam arrangement for a Lt. sided APBI. The beams, arranged clockwise from the left, are as follows: RAIO, RASO, LPSO, LPIO, and LAIO.

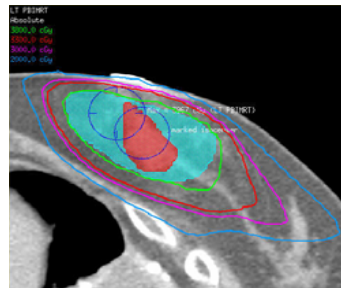


Figure 4. A typical isodose distribution for a Lt. sided APBI. The 3800 cGy isodose line (green) encompasses the CTV (cyan) while limiting the dose to the skin and chestwall to approximately 3000 cGy (pink isodose line).

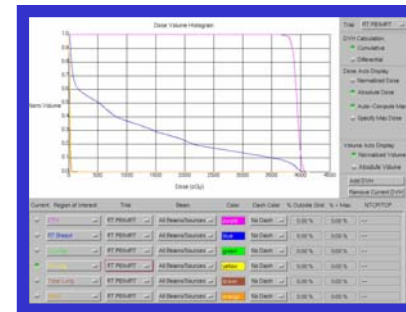


Figure 5. DVH for right breast IMRT plan developed to deliver APBI.

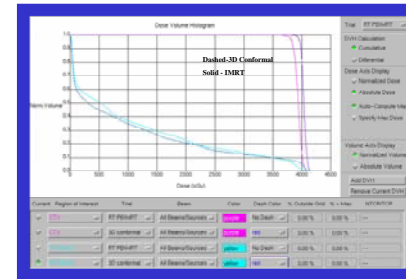


Figure 6. Comparison of IMRT and conformal plans for study defined CTV coverage. Same beam angles are used in the two plans.

Table 1. Dose Volume Statistics for Various Volumes of Interest

ROI	Endpoint	ROI % Volume			NSABP Value
		Median	Min	Max	
Heart	5% Prescribed Dose	0.002	0	25	0
Ipsi-Lung	30% Prescribed Dose	0.4	0	10.7	≤ 15%
Contra-Lung	5% Prescribed Dose	0.36	0	19.5	≤ 15%
Uninvolved Ipsi-Breast	100% Prescribed Dose	1.39	0.325	4.65	≤ 35%
Uninvolved Ipsi-Breast	50% Prescribed Dose	25.2	8.9	49.6	
Contra-Breast	3% Prescribed Dose	1.74	0	26	0
Ipsi-Breast	100% Prescribed Dose	9.23	3.25	22.54	≤ 35%
Ipsi-Breast	50% Prescribed Dose	31.26	11.8	56.65	≤ 60%



Figure 7. Cosmetic results 2 months post treatment.



Figure 8. Cosmetic results 2 years post treatment.