Adaptive Planning Accelerated Partial Breast Irradiation (APBI) on Ethos using Eclipse Treatment Planning System as the Reference Plan

Robert Gleason, Department of Radiation Oncology, Fox Chase Cancer Center, Philadelphia, PA

Definition

Adaptive Radiation Therapy is a revolutionary FDA-approved approach to treatment that allows for real-time adjustments of the radiation plan to account for the cancer's changing responses to radiation therapy such as the size and position of the tumor, and the location of nearby organs, during every radiation.

Introduction

External beam radiation therapy for breast cancer typically involves treating the entire breast for 5 weeks at 180-200cGy a day to a total dose of approximately 4600-5000cGy, followed by a tumor bed boost for one more week of treatment lasting 5-7 fractions to a total dose of 6000cGy. However, more recently it has been widely studied and shown that we can safely treat early- stage breast cancers in a shorter course of radiation and only treat the tumor bed with a margin and not necessarily needing to treat the entire breast with radiation.

Methods

Recent studies have shown that hypofraction in breast cancer has been able to safely establish local control and also not increase side effects, the heart, lung and skin with the increased daily dose per fraction, allowing patients to complete treatment in 3 weeks versus 6 weeks as previously mentioned.

Early-Stage Breast Cancer: APBI NCCN Guidelines

National Comprehensive Cancer Network®

NCCN Guidelines Version 5.2024
Invasive Breast Cancer

NCCN Guidelines Index
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Discussion

PRINCIPLES OF RADIATION THERAPY

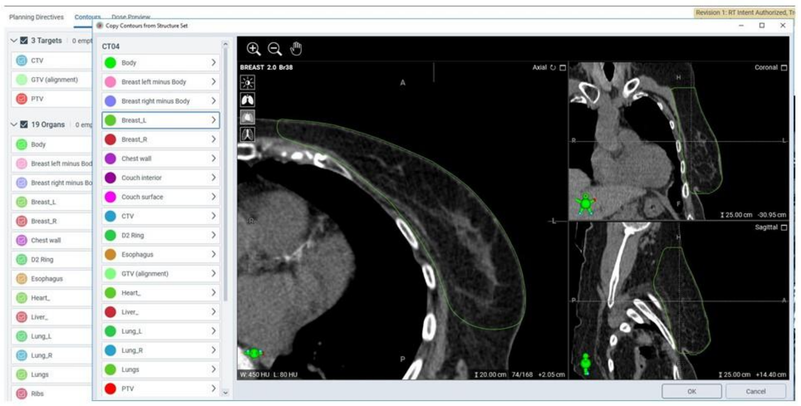
Accelerated Partial Breast Irradiation (APBI)/Partial Breast Irradiation (PBI)

- **APBI/PBI offers comparable local control to WBRT in selected patients with low-risk early-stage breast cancer. However, the optimal external beam-APBI/PBI technique/fractionation for minimizing long-term cosmesis effects has not been determined.**
  - **Patients are encouraged to participate in clinical trials.**
  - **The NCCN Panel recommends APBI/PBI for any patient with no *BRCA* 1/2 mutations meeting the criteria outlined in the 2016 ASTRO consensus statement for guidance on APBI/PBI use.**
  - **According to the 2016 ASTRO criteria, patients aged ≥50 years are "suitable" for APBI/PBI if they have:**
    - **Invasive ductal carcinoma measuring ≤2 cm (pT1 disease) with negative margin widths of ≥2 mm, no LVI, and ER-positive tumors or**
    - **Low/intermediate nuclear grade, screening-detected DCIS measuring size ≤2.5 cm with negative margin widths of ≥3 mm.**
- **RT dosing:**

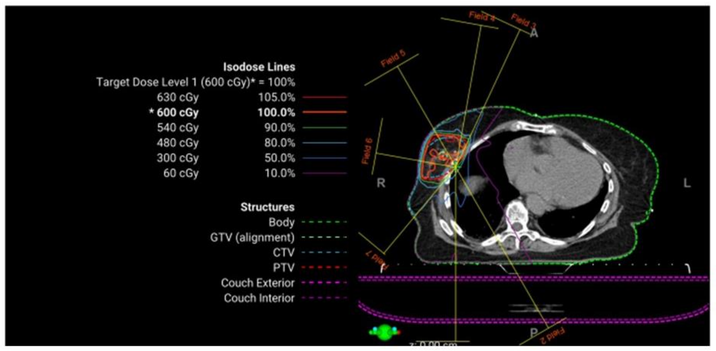
Regimen	Method	Reference
30 Gy/5 fractions QOD (preferred)	**External beam RT (EBRT)[a]**	Livi L, Meattini I, Marrazzo L, et al. Accelerated partial breast irradiation using intensity-modulated radiotherapy versus whole breast irradiation: 5-year survival analysis of a phase 3 randomised controlled trial. Eur J Cancer 2015;51:451-463. Meattini I, Marrazzo L, Saieva C, et al. Accelerated partial-breast irradiation compared with whole-breast irradiation for early breast cancer: Long-term results of the randomized phase III APBI-IMRT-Florence Trial. J Clin Oncol 2020;38:4175-4183.
40 Gy/15 fractions	**EBRT**	Coles CE, Griffin CL, Kirby AM, et al. Partial-breast radiotherapy after breast conservation surgery for patients with early breast cancer (UK IMPORT LOW trial): 5-year results from a multicentre, randomised, controlled, phase 3, non-inferiority trial. Lancet 2017;390:1048-1060.
34 Gy/10 fractions BID	**Balloon/ Interstitial**	Vicini FA, Cecchini RS, White JR, et al. Long-term primary results of accelerated partial breast irradiation after breast-conserving surgery for early-stage breast cancer: a randomised, phase 3, equivalence trial. Lancet 2019;394:2155-2164.
38.5 Gy/10 fractions BID	**EBRT**	Whelan TJ, Julian JA, Berrang TS, et al. External beam accelerated partial breast irradiation versus whole breast irradiation after breast conserving surgery in women with ductal carcinoma in situ and node-negative breast cancer (RAPID): a randomised controlled trial. Lancet 2019;394:2165-2172.

Adaptive Planning Contouring

Click on the structure arrow and attach the associated structure from Eclipse the structure with the same name in Ethos

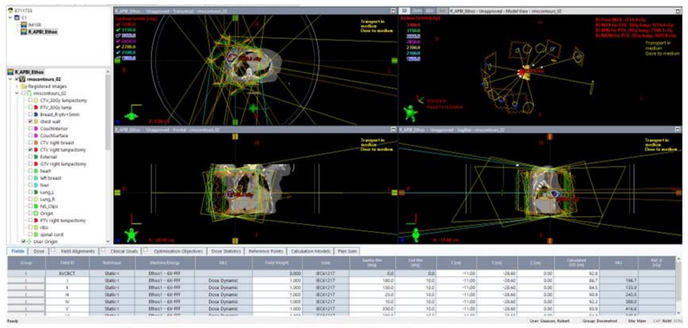


Adaptive Planning Breast APBI Isocenter Placement



Adaptive Planning Breast APBI

When generating a plan in Eclipse choose an isocenter location that is not too lateral as this will cause a collision with the table and the gantry on the Ethos treatment machine. Use the ring and table as a guide when choosing the isocenter location.

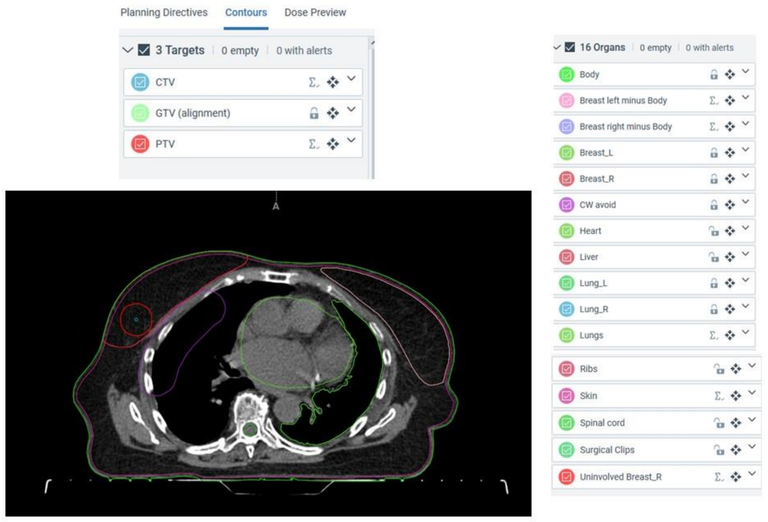


Once an acceptable plan is created and reviewed by the physician in Eclipse, you will then export this plan into Ethos and use this plan and isocenter as the reference plan for the initial treatment. This plan will be re-optimized in Ethos using your existing beams that were chosen in Eclipse.

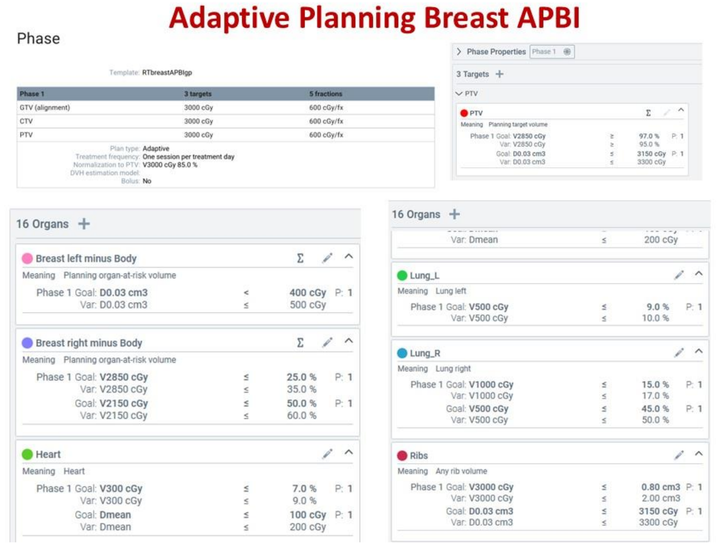
Accelerated Partial Breast Irradiation Target and Critical structure Constraints

Target and Critical Normal Tissue Constraints					
Structure Name	**DVH Objective**	**Evaluator**	**Variation Acceptable**	**Priority**	**Evaluate BED/EQD2**
PTVp_3000	D95%[Gy]	>=28.5	>=27	1	☐
PTVp_3000	D0.03cc[Gy]	Choose operator and enter numeric value	Enter numeric value	-	☐
External_Pat	D0.03cc[Gy]	<=31.5	<=33	2	☐
Heart	V3Gy[%]	<=7	<=10	2	☐
Heart	Mean[Gy]	<=1	<=2	2	☐
Enter Structure Id	Choose constraint and enter values	Choose operator and enter numeric value	Enter numeric value	-	☐
Left Breast	Choose constraint and enter values	Choose operator and enter numeric value	Enter numeric value	-	☐
Breast_L	V15Gy[%]	<=50	<=55	2	☐
Breast_L	V28.5Gy[%]	<=25	<=30	2	☐
Breast_R	D0.03cc[Gy]	<=1	<=3	3	☐
Lung_L	V10Gy[%]	<=15	<=20	2	☐
Lung_L	V5Gy[%]	<=50	<=55	2	☐
Lung_R	V5Gy[%]	<=10	<=15	3	☐
Enter Structure Id	Choose constraint and enter values	Choose operator and enter numeric value	Enter numeric value	-	☐
Right Breast	Choose constraint and enter values	Choose operator and enter numeric value	Enter numeric value	-	☐
Breast_R	V15Gy[%]	<=50	<=55	2	☐
Breast_R	V28.5Gy[%]	<=25	<=30	2	☐
Breast_L	D0.03cc[Gy]	<=1	<=3	3	☐
Lung_R	V10Gy[%]	<=15	<=20	2	☐
Lung_R	V5Gy[%]	<=50	<=55	2	☐
Lung_L	V5Gy[%]	<=10	<=15	3	☐

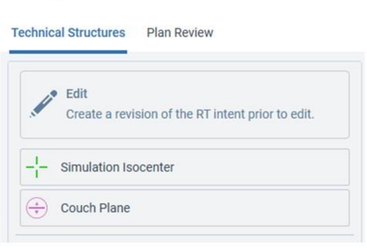
Adaptive Planning Breast APBI Contouring



Adaptive Planning Breast APBI



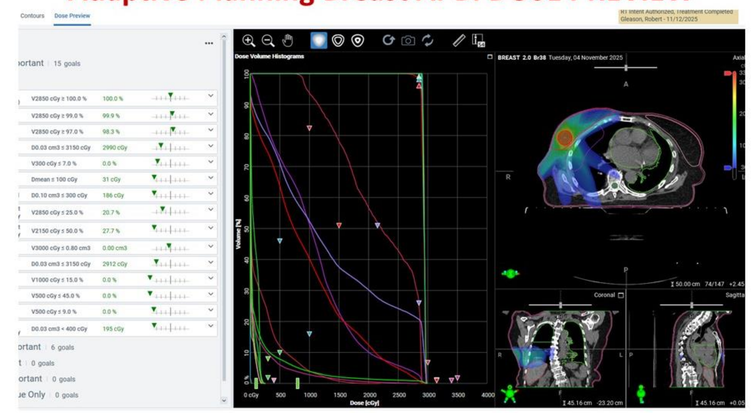
Adaptive Planning Breast APBI Isocenter placement in Ethos



THE PROBLEM IS YOU HAVE TO MAUALLY MOVE THE CURSOR ALIGNING THE ISOCENTER IN EACH PLANE SEPERATELY AND CANNOT JUST TYPE IN THE COORDINATES FOR EACH PLANE

THIS IS TIME CONSUMMING AND WILL NOT BE PERFECT AS THE COORDINATES WILL NOT BE EXACT, BUT SHOULD WITHIN 2MM

Adaptive Planning Breast APBI DOSE PREVIEW



Adaptive Planning Breast APBI PLAN REVIEW

Conclusions: When planning adaptive APBI, due to potential collisions from the iso shift that Ethos makes especially with lateral tumor bed locations and Ethos using beams that enter the contralateral breast, our Institution does the initial reference plan using Eclipse treatment planning system. Our typical beam arrangements are 5-7 static beams with isocenter placed inside the breast of the affected breast and not necessarily in the center of the tumor bed, making sure the table will not collide with the Ethos gantry.