

Purpose / Introduction

At a Glance:

The purpose of this study is to compare the dose-volumetric results of Intensity Modulated Radiation Therapy (IMRT) with a newer technic called Volumetric Modulated Arc Therapy (VMAT) or RapidArc in Eclipse treatment planning system for whole breast cancer irradiation.

Importance:

Number of New Cases and Deaths per 100,000: The number of new cases of breast cancer was 124.6 per 100,000 women per year. The number of deaths was 22.2 per 100,000 women per year. These rates are age-adjusted and based on 2007-2011 cases and deaths.

Lifetime Risk of Developing Cancer: Approximately 12.3 percent of women will be diagnosed with breast cancer at some point during their lifetime, based on 2009-2011 data.

Prevalence of this cancer: In 2011, there were an estimated 2,899,726 women living with breast cancer in the United States¹.

Estimated New Cases in 2014	232,670
% of All New Cancer Cases	14.0%
Estimated Deaths in 2014	40,000
% of All Cancer Deaths	6.8%

RapidArc consists of two components:

(1) treatment planning and (2) treatment delivery and is used for both radiotherapy and radiosurgery patients. RapidArc is an advanced form of IMRT that delivers a precisely-sculpted 3D dose distribution with a 360-degree rotation of the gantry in a single or multi-arc treatment. It uses a dynamic multileaf collimator (MLC), variable dose rate, and variable gantry speed to generate IMRT-quality dose distributions².

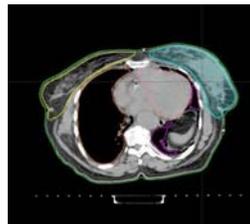


A typical unite

Closer view of the machine head and moving leaves

Method

- 25 patients previously treated for whole left breast (either RapidArc plan or IMRT) were the subjects of this planning study.
- Eclipse v 11.0.47 was used to make all retrospective plans using the same contours, energy, machine and normalization.
- After having the CT images and the tumor contoured by the oncologist, the healthy organs near that need to be contoured as seen in the following pictures.

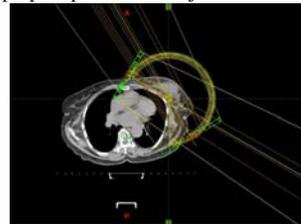


Transvers view

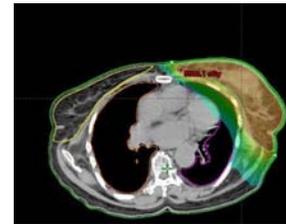


3D view of the contours

- Prescription dose to the planning target volume was 5000 Gy in 25 fractions.
- All plans were normalized such that 100% covered 95% of planning target volume (PTV) that is the whole breast in this study.
- Then it is time to apply the fields and optimized them to get the 5000 Gy prescribed dose to the breast while the dose to other organs is minimized.
- In order to make IMRT plans the dosimetrist chose the best angles possible based on the years of experiences then calculated the dose by applying proper optimization objectives.
- But in RapidArc plans despite IMRT the dosimetrist did not choose a specific angle and instead chose 3 iso-centric Arcs then calculated the dose by applying proper optimization objectives.



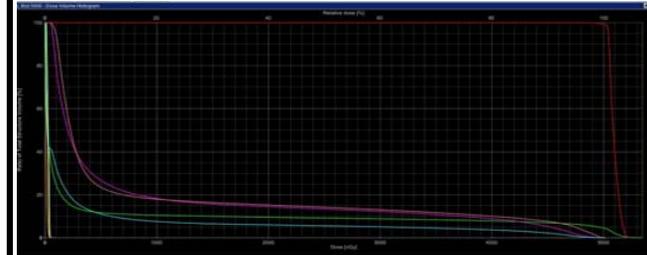
RapidArc beam placement



Calculated dose to the breast and chest area

Analysis / Result / Conclusion

- **Analysis:** After getting the data from the Dose Volume Histogram (DVH) a paired t-test was performed for the comparison of the dose that all the organs receive in that region.



A typical DVH. Colors indicate the dose to the organs as following: red is the breast, pink is the heart, purple is the left lung, blue is the total lungs, yellow is the spinal cord, orange is the right lung.

- **Result:** V10, V20 and Dmean Gy of left lung significantly differed between the two plans (p-value <0.0001, =0.0473 and <0.0001 respectively), but V30 Gy did not (p-value 0.463). V25, D33 and Dmean Gy of heart significantly differed between the two plans (p-value =0.034, <0.0001 and 0.01 respectively), but V10 Gy did not (p-value 0.058). V5 of both right breast and right lung significantly differed between the two plans (p-value <0.0007 and =0.0112, respectively). Also Dmean of both right breast and right lung significantly differed between the two plans (p-value <0.0001 for both). The mean conformity index did not significantly differ, p-value 0.142. There was a significant difference between the mean MUs of the two plans as well, p-value <0.0001.

- **Conclusion:** The dose-volumetric results of IMRT vs RapidArc were different for most of the constraints although all plans were made within the threshold values recommended by RTOGs. Mean doses to left lung, heart, right lung and right breast were significantly different in RapidArc than IMRT plans. It's been said that RapidArc is more efficient/faster in the treatment delivery than IMRT in terms of total monitor units used, but in this study the results did not prove that. In fact, since both plans have the same mean of conformity index, based on what was observed in this study IMRT is not only faster but also safer regarding not irradiating the organs at risk.

Further Studies

- Analyzing and categorizing the data in terms of the size of the breast.
- Applying the none co-planar technique as well.
- Running the same test regarding to machine specifics and observe the differences.

References

1. <http://www.cancer.gov/cancertopics/types/breast>
2. <https://www.varian.com/oncology/treatment-techniques/external-beam-radiation/vmat>