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Influence of Lumpectomy Cavity Depth on 3D Arc-Based SIB Breast Radiotherapy

Introduction

Simultaneous Integrated Boosts (SIB) for whole-breast radiotherapy can be a valuable option for patients when boosting breast lumpectomy cavities by reducing the treatment course length compared to a traditional Sequential Boost (SeqB).[1]

When choosing the type of boost, a 3D arc may be preferable over VMAT due to potential insurance authorization denial of VMAT techniques.

Some studies have shown that when choosing between 3D boost options, an arc-based boost may provide less high dose spillage into the whole breast PTV than traditional 3D static fields.[2]

A remaining gap in the research is how certain geometric factors such as lumpectomy cavity depth affect plan quality and if there is a limiting cavity depth for 3D arc SIBs.[3]

Methods

Patient Selection

30 patients with variable breast laterality, cavity size, depth, and quadrant location were retrospectively selected. Patients had been treated with a hypofractionated intact breast course with a sequential boost without lymph node involvement.

Treatment Planning

A comparison SIB plan was generated for each patient using the existing tangential fields from the SeqB plan. 6x and 10x were used for the arc energies and arc range varied from 39-130 degrees.

Dosimetric Evaluation

Requirements for an acceptable plan:

1 Meet the same target and OAR constraints from the SeqB plans.

2. Dmax had to be within the boost Cavity PTV and under 110%.

Statistical Analysis

1. Geometrical Parameters in Table 1 were analyzed for correlation with SIB pass rate.

2. High dose spillage (defined as 105% of the total breast Rx and 105% of the boost Rx) into the breast PTV volume was compared for the SeqB and SIB plans.

Results

Table 1. Geometric breast parameters evaluated

Geometric Variable	Min	Max	Mean	Std. Dev.
Min Cavity PTV Depth (cm)	0.0	2.34	0.7233	0.5334
Max Cavity PTV Depth (cm)	3.49	9.69	5.315	1.6734
Breast PTV Volume (cc)	261.87	2078.0	989.66	438.94
Cavity PTV Volume (cc)	15.88	167.48	63.443	36.31
Boost Volume Ratio	0.0217	0.2077	0.0711	0.0437
CI100 Cavity PTV	1.105	2.81	1.764	0.3915

Fig 1. Scatter plot with Pearson Correlation Coefficient and p-value of relationship between breast Dmax hotspot and the maximum depth of cavity PTV.

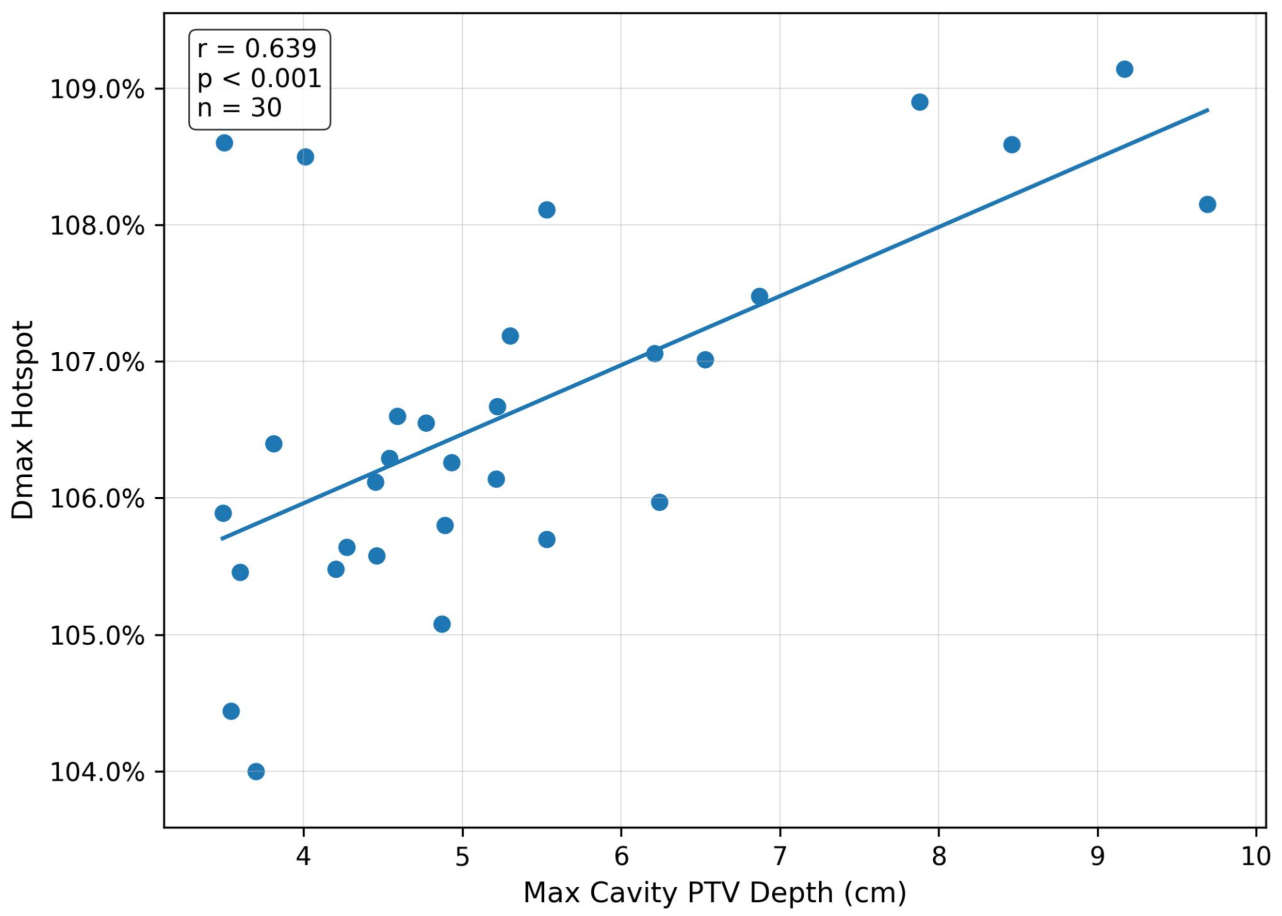
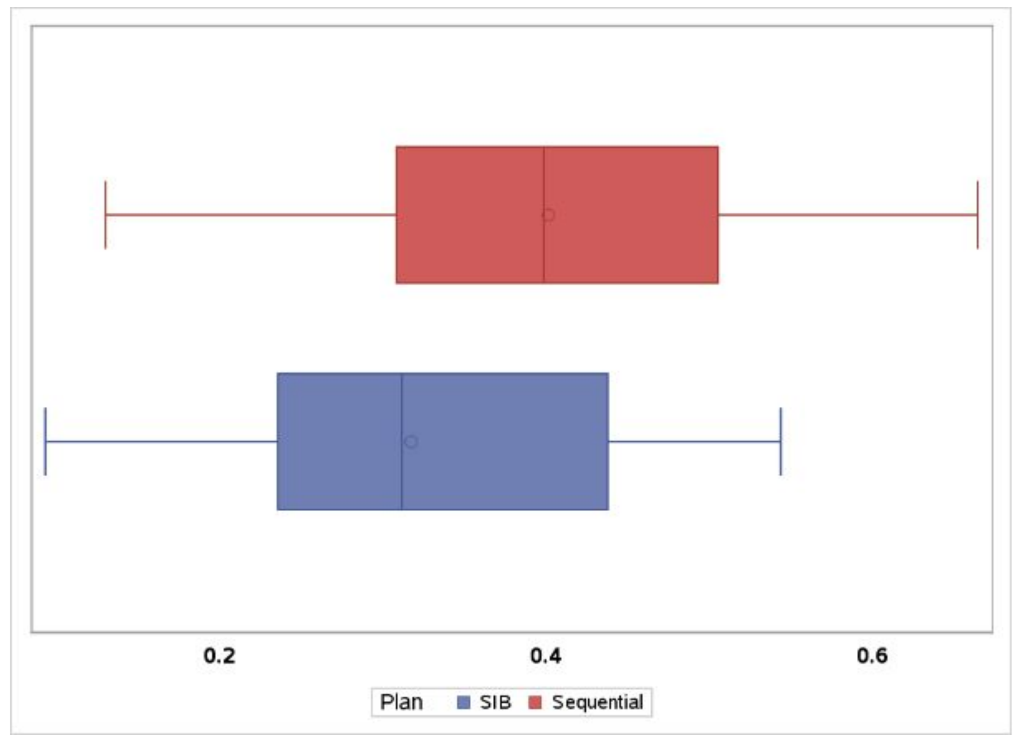


Fig 2. Sign test comparison of SeqB and SIB plans' 105% breast Rx dose spillage from the boost . P Value of <0.0002.



Conclusion

All 30 SIB plans passed constraints. There does not appear to be a limiting lumpectomy cavity depth for 3D arc-based SIB breast plans at the depth investigated.

Parameters which were found to have a statistically significant relationship to the Maximum Cavity PTV were the 105% boost Rx dose spillage, the Cavity PTV Dmax, and the Breast CI100.

3D arc plans offered less dose spillage of the 105% breast Rx dose from the boosts except in some cases of shallow cavities in which electrons were used in the SeqB plan. SeqB plans were found to have minimally less spillage of the 105% of the Boost Rx.

Limitations

The primary limitations of this study were in regards to the patient population and their cavity parameters. The study was limited to 30 patients, with a maximum cavity PTV depth of 9.69cm.

Each quadrant per side was represented by at least one patient, however, some quadrants were represented more often than others in this study.

Low dose spillage was not compared between the SeqB and SIB plans.

References

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