Dosimetric Consequences from Minimal Displacements in APBI with SAVI Applicators

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INTRODUCTION

Accelerated partial breast irradiation (APBI) is introduced few years ago as a High-Dose rate brachytherapy treatment option for patients who have early stage breast cancers. SAVI applicator is a strut based single insertion multi catheter device which is placed in the lumpectomy cavity . Each catheter is then connected to an HDR afterloader for delivery of the radiation source Iridium(Ir 192) to the patient.

Figure 1 – Savi Applicatorrs

Figure 2 – HDR afterloader

PURPOSE

It got popular as a treatment option in recent years due to the convenience, fewer complications, safety and less toxicity it offer to the patient including its ability to minimize the dose to the healthy tissue while maximizing target coverage compared to the other APBI treatment options. Mostly treatment is twice a day for five consecutive days. We present an evaluation of displacement of the applicator inside patient's body, between each treatment to determine the importance of providing proper solid immobilization in every treatment in ABPI.

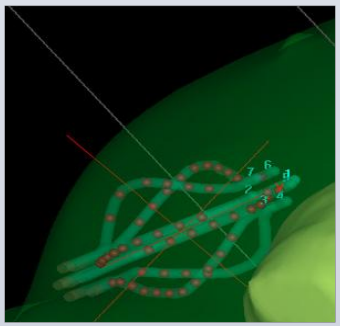

Figure 3 – 3D construction of a SAVI applicator inside lumpectomy cavity

MATERIAL AND METHOD

A retrospective analysis of 100 patients treated with brachytherapy based SAVI applicators at SFRO Boca Raton, from 2013-2014 were considered for this study. All patients received monotherapy APBI in 10 fractions (340cGy). The CT scans of each patient which were taken before each treatment were imported in to the planning system. The series of CT scan images were loaded on Oncentra and 3 chosen catheters (Channels) were located. Displacements from these 3 channels of the applicator (Catheters) in reference to ribs and skin surface were measured separately for each CT scan image in all 10 fractions. Then these displacements were compared with the displacement of the initial CT scan which was used for the initial plan. Deviation in displacements compared to the initial image was measured for each patient. Then dosimetric evaluations respective to the initial image were performed for each patient.

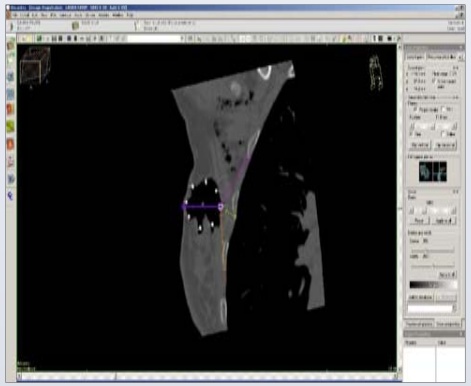

Figure 4 - Distance to the ribs and skin from Channel 4 of SAVI applicator

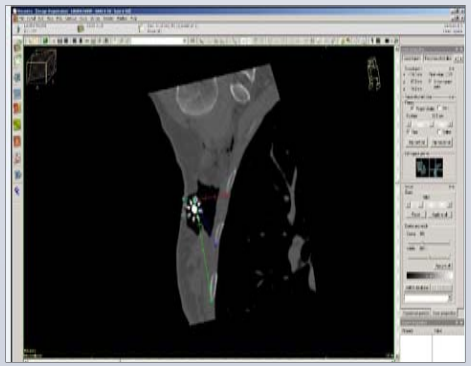

Figure 5 - Distance to the ribs and skin from Channel 6 of SAVI applicator

RESULTS

❑ Following tables and figures shows the measured displacements from 3 channels in reference to ribs and skin surface for 10 fractions and also the measured deviation in displacements ,respect to the first fraction for a one patient.

Table 1 – Displacements

	Ribs			Skin		
Fraction ID	Channel 2(mm)	Channel 4(mm)	Channel 6(mm)	Channel 2(mm)	Channel 4(mm)	Channel 6(mm)
1	79.8	74.2	45.9	26.7	34.3	14.0
2	69.6	64.2	54.3	17.4	36.5	11.4
3	77.6	62.3	55.3	13.9	37.2	14.5
4	53.9	45.7	32.4	14.6	36.1	12.6
5	83.6	74.6	62.9	16.2	36.8	12.2
6	77.8	68.2	56.3	17.2	36.1	11.9
7	72.1	59.0	46.7	18.1	35.2	12.3
8	67.3	63.1	51.0	15.3	34.8	10.8
9	57.9	58.9	64.2	14.7	36.0	10.1
10	74.1	68.8	51.1	17.2	36.4	13.3

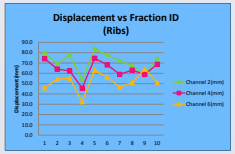

Figure 6 – Displacement variation in every fraction(Ribs)

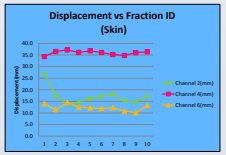

Figure 7- Displacement variation in every fraction(Skin)

❑ Following table show the calculated deviation of displacement from 3 channels of the SAVI applicator to the ribs and skin surface for each fraction compared to the first fraction.

Table 2- Deviation of displacements

	Ribs			Skin		
Fraction ID	Channel 2(mm)	Channel 4(mm)	Channel 6(mm)	Channel 2(mm)	Channel 4(mm)	Channel 6(mm)
1	0.0	0.0	0.0	0.0	0.0	0.0
2	10.2	10.0	8.4	9.3	2.2	2.6
3	2.2	11.9	9.4	12.8	2.9	0.5
4	25.9	28.5	13.5	12.1	1.8	1.4
5	3.8	0.4	17.0	10.5	2.5	1.8
6	2.0	6.0	10.4	9.5	1.8	2.1
7	7.7	15.2	0.8	8.6	0.9	1.7
8	12.5	11.1	5.1	11.4	0.5	3.2
9	21.9	15.3	18.3	12.0	1.7	3.9
10	5.7	5.4	5.2	9.5	2.1	0.7

❑15 patient data was used for the following analysis. Small deviations in displacements were observed from the SAVI applicator(channels) to the ribs and the skin surface in all cases.

❑But some cases show a significant difference which can not be neglected.

❑Dosimetric evaluations revealed, even very small changes in the inter-fractionation position make significant differences in the maximum dose to these critical organs.

❑Additionally, Volume of the cavity also changed between fractions.

❑As a result, the maximum dose manifested variance between 10% and 30% in ribs and skin surface.

CONCLUSION

It appears that taking CT scan before each treatment is necessary to minimize the risk of delivering undesired high doses to the critical organs. This study indicates, in 30% of the cases re-planning was necessary between treatments. We conclude that, treatment planning teams should evaluate the placement of the device by analyzing the CT images before each treatment and they must be prepared for re-planning if needed. Also this study reveals the urgent need of improving the immobilization methods when treating APBI with SAVI applicator.

Future Studies/Extensions

➢ Complete the data gathering for 125 patients and use advance statistics methods for data analysis.

➢ Study about the impact the size of the lumpectomy cavity has on the deviations.

➢Study about the alternate CT scan options.

REFERENCES

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